Volume 1

Geology

ILLINOIS RIVER BLUFFS AREA ASSESSMENT

ILLINOIS
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ILLINOIS RIVER BLUFFS
AREA ASSESSMENT.

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VOLUME 1: GEOLOGY

Illinois Department of Natural Resources
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State Geological Survey Division
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About This Report

The Illinois River Bluffs Area Assessment examines an area in west-central Illinois that includes parts of the upper and lower Illinois River watersheds from the vicinity of Hennepin southward to East Peoria. Because significant natural community and species diversity is found in the area, it has been designated a state Resource Rich Area.[1]

This report is part of a series of reports on areas of Illinois where a public-private partnership has been formed. These assessments provide information on the natural and human resources of the areas as a basis for managing and improving their ecosystems. The determination of resource rich areas and development of ecosystem-based information and management programs in Illinois are the result of three processes -- the Critical Trends Assessment Program, the Conservation Congress, and the Water Resources and Land Use Priorities Task Force.

Background

The Critical Trends Assessment Program (CTAP) documents changes in ecological conditions. In 1994, using existing information, the program provided a baseline of ecological conditions.[2] Three conclusions were drawn from the baseline investigation:

1. the emission and discharge of regulated pollutants over the past 20 years has declined, in some cases dramatically,
2. existing data suggest that the condition of natural ecosystems in Illinois is rapidly declining as a result of fragmentation and continued stress, and
3. data designed to monitor compliance with environmental regulations or the status of individual species are not sufficient to assess ecosystem health statewide.

Based on these findings, CTAP has begun to develop methods to systematically monitor ecological conditions and provide information for ecosystem-based management. Five components make up this effort:

1. identify resource rich areas,
2. conduct regional assessments,
3. publish an atlas and inventory of Illinois landcover,
4. train volunteers to collect ecological indicator data, and
5. develop an educational science curriculum which incorporates data collection

[1] See *Inventory of Resource Rich Areas in Illinois: An Evaluation of Ecological Resources.*
[2] See *The Changing Illinois Environment: Critical Trends*, summary report and volumes 1-7.

At the same time that CTAP was publishing its baseline findings, the Illinois Conservation Congress and the Water Resources and Land Use Priorities Task Force were presenting their respective findings. These groups agreed with the CTAP conclusion that the state's ecosystems were declining. Better stewardship was needed, and they determined that a voluntary, incentive-based, grassroots approach would be the most appropriate, one that recognized the inter-relatedness of economic development and natural resource protection and enhancement.

From the three initiatives was born Conservation 2000, a six-year program to begin reversing ecosystem degradation, primarily through the Ecosystems Program, a cooperative process of public-private partnerships that are intended to merge natural resource stewardship with economic and recreational development. To achieve this goal, the program will provide financial incentives and technical assistance to private landowners. The Rock River and Cache River were designated as the first Ecosystem Partnership areas.

At the same time, CTAP identified 30 Resource Rich Areas (RRAs) throughout the state. In RRAs where Ecosystem Partnerships have been formed, CTAP is providing an assessment of the area, drawing from ecological and socio-economic databases to give an overview of the region's resources -- geologic, edaphic, hydrologic, biotic, and socio-economic. Although several of the analyses are somewhat restricted by spatial and/or temporal limitations of the data, they help to identify information gaps and additional opportunities and constraints to establishing long-term monitoring programs in the partnership areas.

The Illinois River Bluffs Assessment

The Illinois River Bluffs Assessment covers an area of about 560,871 acres in west central Illinois. It includes parts of the upper and lower Illinois River watersheds from the vicinity of Hennepin southward to East Peoria. Counties encompassed in this assessment include most of Marshall and Woodford counties as well as small portions of Stark, Bureau, La Salle, Tazewell, Putnam, and Peoria counties. In addition to containing a portion of the Illinois River Drainage basin (Illinois River upper and lower), this area also encompasses portions of the Crow Creek west, Sandy Creek, Senachwine Creek and Crow Creek east drainage basins as identified by the Illinois Environmental Protection Agency. Three of the sub-basins in this assessment area (Illinois River lower, Senachwine Creek, and Crow Creek east) were designated as "Resource Rich Areas" (a total of 277,847 acres) because they contain significant natural community diversity. The Illinois River Bluffs Ecosystem Partnership was subsequently formed around this core area of high quality ecological resources.

This assessment is comprised of five volumes. In Volume 1, *Geology* discusses the geology, soils, and minerals in the assessment area. Volume 2, *Water Resources*, discusses the surface and groundwater resources and Volume 3, *Living Resources*, describes the natural vegetation communities and the fauna of the region. Volume 4

Major Drainage Basins of Illinois and Location of the Illinois River Bluffs Assessment Area

Subbasins in the Illinois River Bluffs Assessment Area. Subbasin boundaries depicted are those determined by the Illinois Environmental Protection Agency.

contains three parts: Part I, *Socio-Economic Profile*, discusses the demographics, infrastructure, and economy of the area, focusing on the three counties with the greatest amount of land in the area — Marshall, Peoria and Woodford; Part II, *Environmental Quality*, discusses air and water quality, and hazardous and toxic waste generation and management in the area; and Part III, *Archaeological Resources*, identifies and assesses the archaeological sites, ranging from the Paleoindian Prehistoric (B.C. 10,000) to the Historic (A.D. 1650), known in the assessment watershed. Volume 5, *Early Accounts of the Ecology of the Illinois River Bluffs Area*, describes the ecology of the area as recorded by historical writings of explorers, pioneers, early visitors and early historians.

Contributors

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Introduction: Influence of Geology and Soils on Ecosystem Development

> *Geology is . . . the original source of inorganic chemical nutrients for the biosphere and provides the abiotic physical environment of the biosphere. Through knowledge of rock type mineralogy, the geologist can predict the amount and variety of toxic or beneficial inorganic chemical nutrients present. . . . Geological processes modifying geologic materials create landforms that are commonly a basis for land unit hierarchies. Geologists can increase understanding of land unit hierarchies in ecosystem studies . . . . Geologists can be critical players in understanding ecosystems.*[1]

> *The "Natural Divisions of Illinois" is a classification of the natural environments and biotic communities of Illinois based on physiography, flora, and fauna. . . . Factors considered in delimiting the 14 natural divisions are topography, soils, bedrock, glacial history, and the distribution of plants and animals.*[2]

In the few areas of the earth that have not been modified by human settlement, the patterns of vegetation and the animals that interact with vegetation are directly influenced by geological factors. In fact, in undisturbed areas, surficial geology and to some extent bedrock geology can be mapped using inferences drawn from vegetation patterns observed on air photographs and satellite images and during field observations. For example, in the pristine terrains of northern North America, ecosystem variations were used to infer and eventually map underlying geological conditions.

The geological characteristics that most influence ecosystem development are soil moisture and composition, topography (including slope angle, slope direction, and local drainage), and texture of the parent material. In some places, geological events such as earthquakes, glacial advances and retreats, and volcanic eruptions exert a strong influence over ecosystems. Even animal activities that are seemingly removed from geological control are influenced by geological factors such as availability of salt for migrating herds, availability of suitable vegetation for food, or—in the case of carnivores—suitable colonies of prey that congregate near geologically controlled food sources.

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[1] P. Hughes, A geologic response to the Seventh American Forest Congress and Round Tables: Environmental Geology 28 (1) July 1996, p. 52–53.

[2] Comprehensive Plan for the Illinois Nature Preserves System, Part 2, The Natural Divisions of Illinois, John E. Schwegman, principal author, 1984, Illinois Nature Preserves Commission, p. 3.

In uninhabited areas of the glaciated North American Arctic, ridges of gravel (eskers) left by retreating glaciers served as transportation routes for early humans and animals alike. The ridges provided ease of footing, vantage points for hunters or the hunted, and protection from ravenous insects that prefer the calmer air of low-lying areas. Even in modern America, roads in New England are often constructed on these ridges. These examples clearly illustrate the dominant role local geologic factors can play in ecosystem development.

Before human settlement, the whole panoply of Illinois' ecological components was in equilibrium with the geology and climate of each area. The original ecological systems were closely attuned to the variety of near-surface conditions that are generated by the distribution of glacial deposits and by spatial variations in bedrock units.

Glacial moraines (arc-shaped ridges) in northeastern Illinois provided well-drained soils for forest growth and refuge for forest-dwelling animals. The low, flat plains are sites where shallow lakes were dammed between moraines and became poorly drained seas of herbaceous plants whose luxuriant growth provided the biomass for the thick organic-rich soils that support so much agriculture. Illinois' soils developed on tills or thick loess that are mixtures of crushed bedrock particles. These soil parent materials, formed and homogenized by the grinding action of glaciers, supply abundant nutrients vital to the crops that are the agricultural basis of our society.

Where glaciers did not cover the terrain, the topography, soils, and vegetation differed significantly. The soils are directly related to the composition of the immediately underlying bedrock from which they were formed by chemical and physical weathering. The contrasts in our ancient ecosystems can be imagined by observing the ways modern society has adjusted to the differences between the soils of the glaciated and unglaciated parts of the state: except on alluvial plains, crops are not a major source of income outside the large area of the state that was glaciated.

On our modern landscape, original ecosystems cannot be restored or maintained without respecting the geologic factors that generated the original complex plant and animal interrelations. For instance, attempting to reestablish a wetland consisting of acid-loving plants that require periodic drying will not succeed in depressions actively fed by groundwater that passes through alkaline glacial till. Likewise, reestablishing certain types of forest vegetation on an unstable terrain underlain by thick, easily erodible loess is likely to fail.

> *Land on a high terrace of the Illinois River, about 100 feet above the river channel, was purchased for wetlands restoration. The permanent water table was 9 feet below the surface, and the sandy soils were highly permeable. Wetlands plants installed at the site died and were replaced naturally by upland plant species tolerant of the dry conditions. Had readily available information on the geology and hydrogeology of the area been taken into consideration, it would have clearly indicated that this site was inappropriate as a potential wetlands compensation site. Given that the existence of wetlands depends on hydrology, and hydrology depends on*

geologic and geomorphic factors, such information identifies areas most favorable for the occurrence of wetlands or wetland mitigation.
—Michael V. Miller, Illinois State Geological Survey

Hine's emerald dragonfly, a federally listed endangered species, is associated with seep areas that receive groundwater flows from dolomitic limestone formations. The exact habitat requirements of larvae and adults are still unclear. —Illinois Natural History Survey Annual Report, 1995–1996, p. 10

These two examples of the interrelations between geology and ecosystem elements illustrate the four geologic factors considered by the Illinois Nature Preserves Commission (Schwegman 1984) in delineating the 14 natural divisions of the state: (1) topography (high terrace of a river channel), (2) soils (sandy permeable soils), (3) bedrock (dolomitic limestone formations), and (4) glacial history (the Illinois River channel's location and configuration are due largely to the area's glacial history).

Topography, or landscape features such as hills or valleys, influences the biota of Illinois by controlling the diversity of habitats: generally, the more rugged the topography, the greater the diversity. The type of ***bedrock*** is often reflected by a characteristic topography (for example, hard and resistant sandstone forms bluffs and ledges, whereas soft and erodible shale forms smooth slopes). Bedrock also exerts a control on plant life because thin soils commonly develop in it. A crucial factor in controlling ***soil type*** is the geologic material in which the soil developed (parent material); the diversity of soil parent materials is partly responsible for the varied environments and biota within ecosystems. The ***history of glaciers*** advancing into and retreating from Illinois has played a major role in shaping the topography of the landscape: the subdued, irregular topography characteristic of recently glaciated areas generally is poorly drained, resulting in an abundance of aquatic habitats (Schwegman 1984).

An interesting example of the interrelationships between geology and ecosystems is an observation made at certain landfills in which the water table assumes a mounded shape within the landfill. Cattails have been observed to grow where the water table is high, and cattails help clean up the water by taking some of the pollutants out of the leachate.
—Keros Cartwright, Illinois State Geological Survey

Water is a crucial element in each of the preceding examples. Water is also an inherent aspect of the four geologic factors used to delineate natural divisions: topography determines drainage; soil moisture is a function of soil texture; bedrock types determine resistance to erosion; and glacial materials, which range from clayey glacial tills (see Glacial and Surficial Geology section) to sands and gravels, vary widely in texture, moisture-holding capacity, and ability to yield moisture to plants (Schwegman 1984).

* * *

The geologic characteristics of the assessment area—from bedrock to the surface soils in the glacial sediments—are a product of continuous interactions between natural processes and materials. In accord with this natural order, Part 1 of this volume, *The Natural Geologic Setting*, is organized "from the bottom up"—that is, we begin by describing the bedrock geology, then work our way upward from the bedrock surface and describe the sediments and features that stack on top of each other until they reach the landscape on which we live. This approach may seem counterintuitive to many readers: why don't we begin at the surface, with the geology we can see, and work our way downward? We believe the strategy we have chosen is more logical and natural for two reasons: (1) it reflects the chronological order in which geologic materials were emplaced, and (2) it better describes how the bedrock geology and glacial deposits influence each other and how they combine to create the surface landscape upon which life exists.

Part 2 of this volume, *Geology and Society*, examines the use of geologic resources within the assessment area and some of the consequences and hazards from the extraction of resources . It also describes some of the major natural and society-induced geologic hazards that can occur in the assessment area.

The following discussions are generalized for the entire Illinois River Bluffs Assessment Area (Figure 1) and cannot be used for site-specific purposes. Users needing more detailed information should contact the authors at

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The databases used in this report are discussed in Appendix A.

The maps reproduced in this volume are small-scale versions of preliminary work maps used by the authors in preparation of their sections. The level of detail in these maps is limited by the page size and type and quality of printing available for the reproduction of this report. In general, these maps are suitable for general planning and information purposes. Higher-detail and higher-resolution maps suitable for more specific applications and assessments can be consulted or obtained by contacting the authors at the Illinois State Geological Survey.

That Illinois is incorporating geologic data into this report on the Illinois River Bluffs Assessment Area and into reports on other assessment areas in the state is an appropriate recognition of the necessity of integrating geologic and biological data into efforts to preserve our natural heritage.

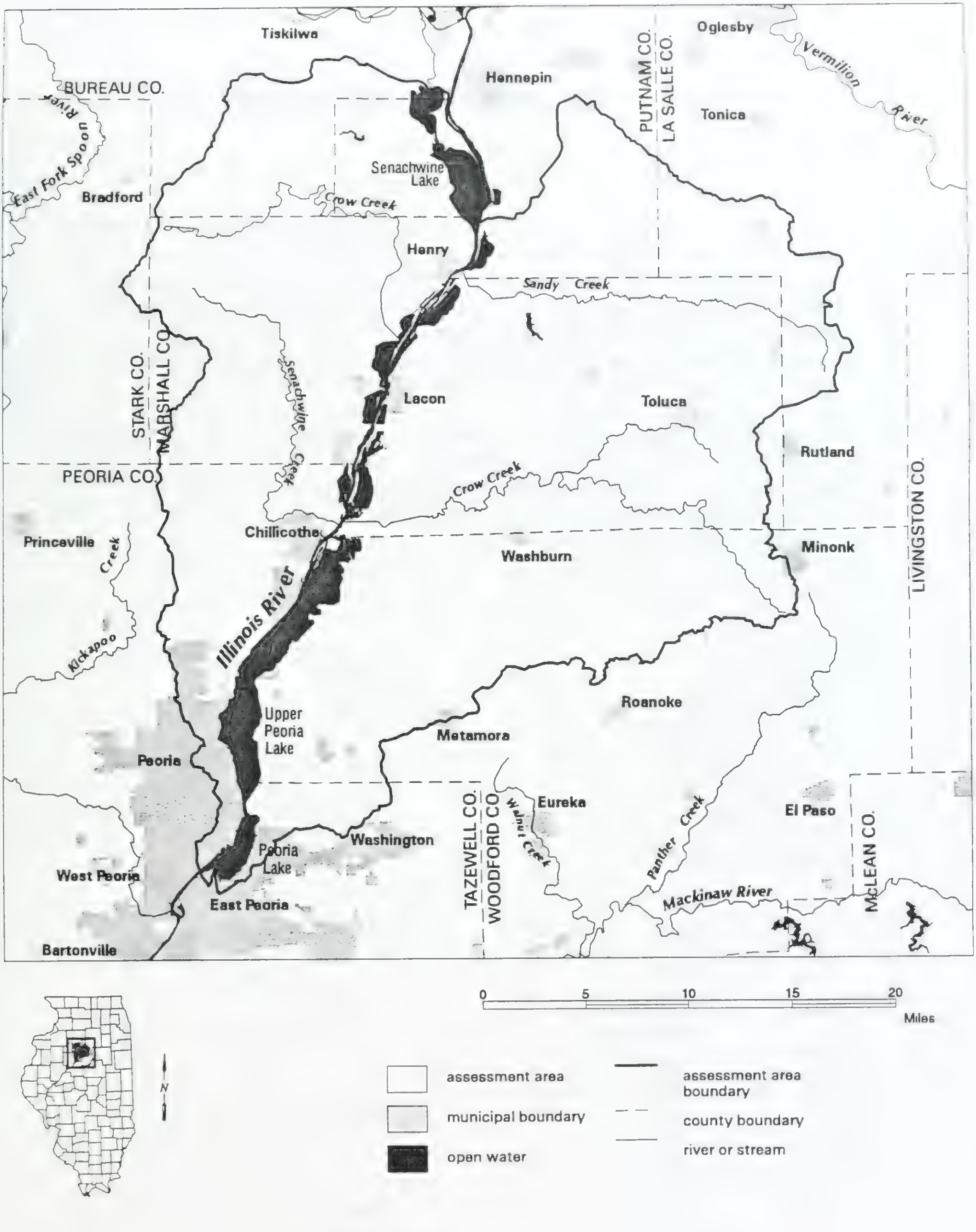


Figure 1. Illinois River Bluffs Assessment Area

Part 1: The Natural Geologic Setting

Imagine that you are standing on the valley side overlooking the floodplain of the Illinois River. In the distance you see broad, flat plains, gently rolling hills, and perhaps a tributary valley. Now imagine that about 100 feet below that surface, lies another landscape, complete with rolling hills, flat plains, and valleys. This is the buried bedrock surface: the foundation of the geologic framework on which we live. Every aspect of this surface—its shape, its composition, its stability—and every aspect of the layers of earth materials above the bedrock surface exerts some control on life at the surface of the earth.

The nature of the geologic framework below us plays a key role in where flora and fauna live, where streams flow, where humans build their homes, factories, and cities, and where land is set aside for parks and natural areas. Part 1 discusses the geologic framework of the Illinois River Bluffs Assessment Area and, where possible, describes how the geology relates to ecosystems and habitats.

Bedrock Geology

Description of Materials

Bedrock beneath the mantle of glacial-related Quaternary sediments in the Illinois River Bluffs Assessment Area consists of sedimentary rocks of Pennsylvanian age (Figures 2 and 3). These strata consist of many relatively thin layers of sandstone, siltstone, shale, limestone, and coal; sandstone, siltstone, and shale are the dominant rock types (Figure 2).

In the Illinois River Bluffs Assessment Area, the Pennsylvanian strata are separated into three formations (Kosanke and others 1960, Willman and others 1967), which are rather similar in appearance, but can be distinguished by their overall lithologic characteristics. The top or bottom of each formation is marked by key beds (rock layers with diagnostic features). The oldest and lowermost Pennsylvanian unit, the Carbondale Formation, contains the thickest and most widespread coal beds in Illinois. The Colchester Coal, one of the most extensive coal beds in the United States, is a member of the Carbondale Formation (Hopkins and Simon 1975) (see Mineral Resources section below). The Modesto

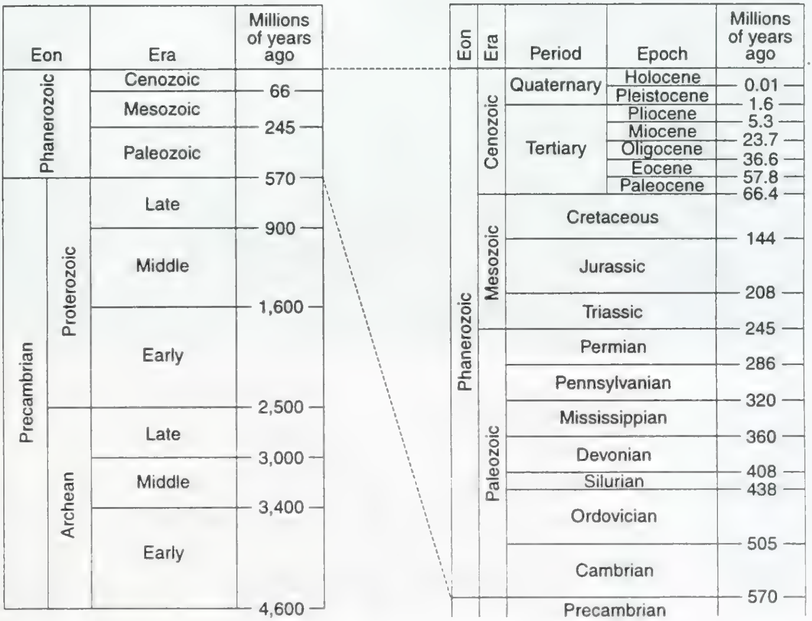


Figure 2. Major Subdivision of Geologic Time (Palmer 1983)

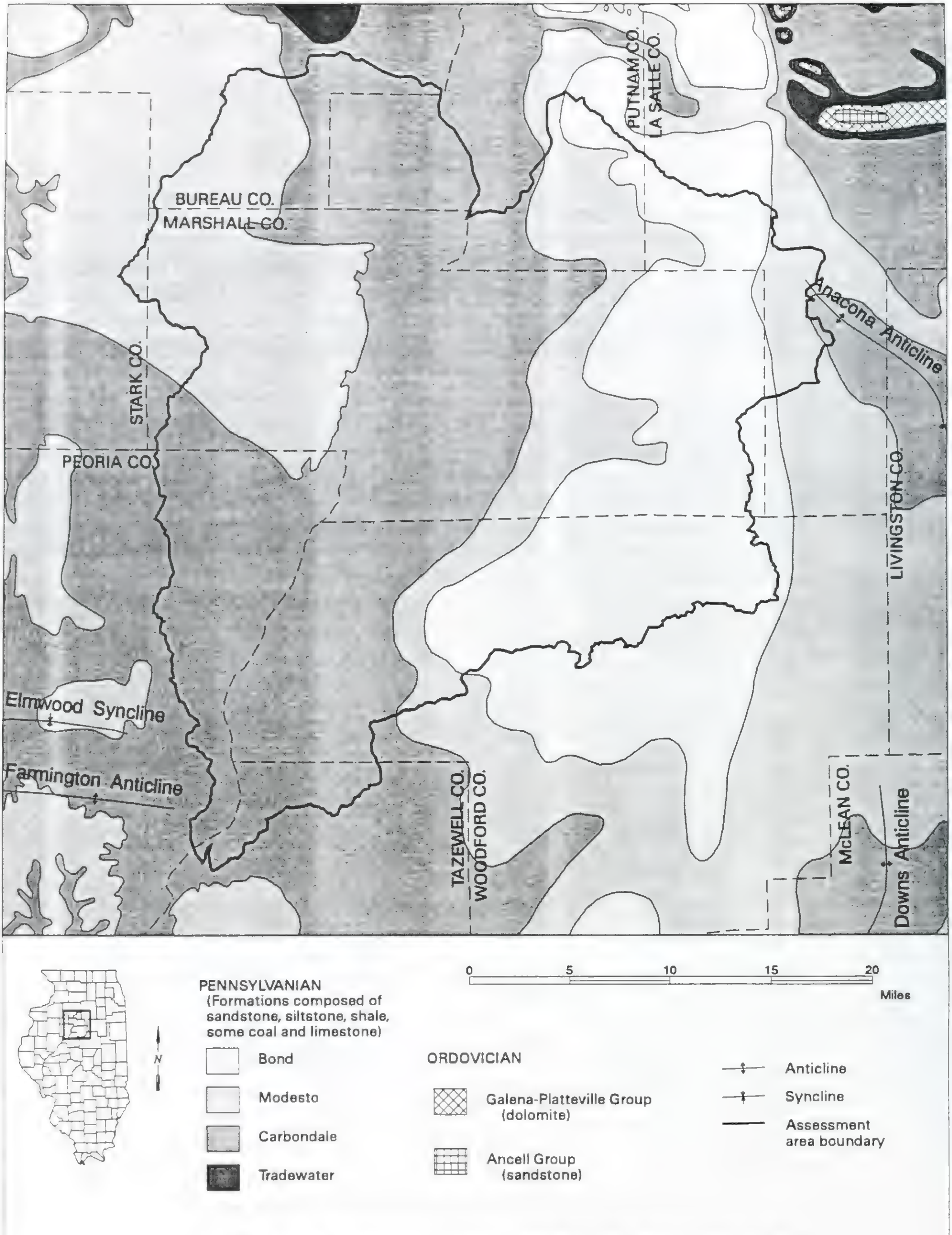


Figure 3. Bedrock Geology (modified after Willman and others 1967)

Formation, which overlies the Carbondale, contains widespread, relatively thick, argillaceous (clayey) limestones and thin coals. The Bond Formation, at the top of the Pennsylvanian succession in the area, is characterized by several thick, pure limestones.

Strata within this assessment area are generally undeformed, but dip gently to the south-southeast toward the center of the Illinois Basin. A few anticlines and synclines occur just beyond the edge of the area (Figure 3).

Bedrock Topography

The buried bedrock surface in the Illinois River Bluff Assessment Area has a complex topography containing buried valleys, lowlands, and uplands (Figure 4). Buried bedrock valleys commonly are filled with coarse-grained sediments (sands and gravels) that can form important, productive aquifers (Horberg 1945). Although a drainage system existed in Illinois (perhaps in Late Tertiary time) before the first glaciers covered the area, the system was substantially modified during the early and middle Pleistocene (Kempton and others 1991). A large valley that was eroded into the bedrock surface is present in the assessment area (Horberg 1950). The Ancient Mississippi Bedrock Valley traverses north–south through the entire assessment area. This buried bedrock valley is sub-parallel to and in some places coincident with the modern Illinois River. In the west part of the assessment area, the buried Wyoming Valley trends southeast and joins the Ancient Mississippi Bedrock Valley. At the north edge of the area, the buried Ticona Valley, coming from the east, joins the Ancient Mississippi Bedrock Valley. At scattered, isolated sites, the modern Illinois River and its tributaries have eroded into Pennsylvanian age bedrock.

References

Greb, S.F., D.A. Williams, and A.D. Williamson, 1992, Geology and Stratigraphy of the Western Kentucky Coal Field: Kentucky Geological Survey, Series XI, Bulletin 2, 77 p.

Herzog, B.L., B.J. Stiff, C.A. Chenoweth, K.L. Warner, J.B. Sieverling, and C. Avery, 1994, Buried Bedrock Surface of Illinois: Illinois State Geological Survey Map 5.

Hopkins, M.E., and J.A. Simon, 1975, Pennsylvanian System, *in* H.B. Willman and others, Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin 95, 261 p.

Horberg, L., 1945, A major buried valley in east-central Illinois and its regional relationships: Journal of Geology, v. 53, no. 5, p. 349–359.

Horberg, L., 1950, Bedrock Topography of Illinois: Illinois State Geological Survey Bulletin 73, 111 p.

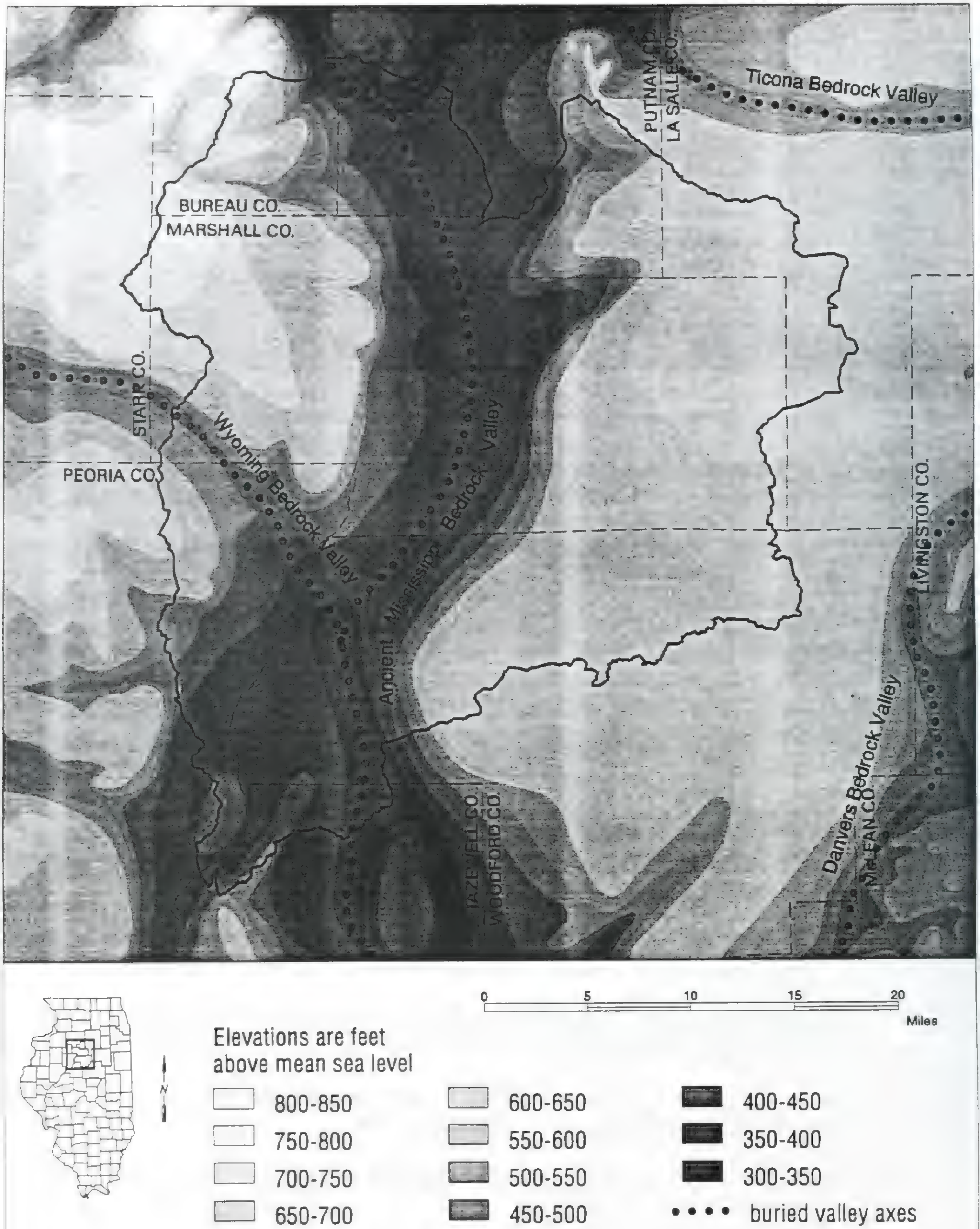


Figure 4. Bedrock Topography and Buried Valleys (modified after Herzog and others 1994)

Kempton, J.P., W.H. Johnson, P.C. Heigold, and K. Cartwright, 1991, Mahomet bedrock valley in east-central Illinois—Topography, glacial drift stratigraphy and hydrogeology, *in* W.N. Melhorn and J.P. Kempton, eds., Geology and Hydrogeology of the Teays-Mahomet Bedrock Valley System: Geological Society of America Special Paper 258, p. 91–124.

Kosanke, R.M., J.A. Simon, H.R. Wanless, and H.B. Willman, 1960, Classification of the Pennsylvanian Strata of Illinois: Illinois State Geological Survey Report of Investigations 214, 84 p.

Palmer, A.R., 1983, The decade of American geology—1983 geologic time scale: Geology, vol. 11, p. 503–504.

Willman, H.B., J.C. Frye, J.A. Simon, K.E. Clegg, C. Collinson, J.A. Lineback, and T.C. Buschbach, 1967, Geologic Map of Illinois: Illinois State Geological Survey, 1:500,000-scale map.

Glacial and Surficial Geology

Description of Materials

Most of the unlithified sediments that overlie the bedrock were deposited by the succession of continental glaciers that advanced across the area during the Pleistocene Epoch, or Great Ice Age. These sediments fall into two major categories: ***till*** (sometimes called diamicton by geologists) and ***outwash***. Less common types of deposits include ***lacustrine*** (lake) sediments and ***organic-rich*** debris (peat). Overlying the deposits of glacial origin is a windblown silt, or ***loess*** (pronounced "luss"), of late glacial and post-glacial age. Collectively, glacial sediments are called glacial drift. Knowledge about these deposits is especially important because they strongly influence land use, ecosystem development, landscape processes that can affect ecosystems (see also Modern Soils and the Landscape—Influences on Habitats and Agriculture section below), and the effects of geologic hazards.

Till is a mixture of all sizes of rocks and ground-up rock debris, ranging from the smallest clay particles to the largest boulders. Most till is a compact mixture of clay, silt, and sand particles that provides the matrix that surrounds and supports larger grains, such as pebbles, cobbles, and boulders. Some till was deposited across the pre-existing landscape at the base of the glacier as it moved forward; other till is sediment that flowed as a muddy mass of material off the front of the melting ice sheet or through crevasses (cracks) that developed within the ice. Each layer (or bed) of till may represent a particular glacial advance that can be recognized over large regions. These layers help identify major groups of sediment associated with particular glacial episodes.

When exposed in stream banks, the dense, compact till can be involved in slumping and minor landslides (see Landslides subsection below). During the infrequent earthquakes experienced in the area, however, till is less likely to enhance seismic energy than the loose, water-saturated sediments found along river floodplains.

Outwash is sand and gravel that literally "washed out" from the ice in meltwater streams along the front of a glacier. Outwash is found in (1) stream valleys that served as meltwater outlets in front of, or beneath, the glacier, (2) fan-shaped deposits in front of end moraines (the arc-shaped ridges of till that built up on the landscape where the ice margin temporarily stabilized), and (3) occasionally as isolated hillocks and ridges on the landscape that formed where meltwater carrying rock debris plunged through crevasses in the ice. Where extensive layers of outwash are associated with particular tills, the identification of the tills in drillholes helps geologists predict the occurrence of major bodies of outwash that can serve as aquifers.

Outwash is a potential resource for construction sand and gravel (see Mineral Resources section below). Layers (or beds) of outwash also occur within the glacial sediments between

bedrock and today's land surface. Such sand and gravel deposits are generally porous and permeable; that is, fluids such as water can move easily among the grains. When thick enough, these deposits can be excellent aquifers (see Aquifer Delineation section below).

Lacustrine (lake) deposits generally consist of fine grained sediments such as silt and clay deposited in temporary lakes that commonly formed along the margin of the ice as it melted or between a moraine and the melting ice front. These sediments commonly are poorly drained and may cause water problems in construction projects.

Organic-rich layers of sediment that sometimes occur between layers of glacial sediment can serve as important marker beds that represent major intervals of warmer climate between glaciations during which soils developed and vegetation grew. Organic deposits that separate major sequences of glacial sediments help geologists interpret the sequence of deposits and predict where outwash may occur below the surface. The low bearing capacity (weight the ground can safely support) of organic soils can affect construction.

Loess, a windblown silt, blankets much of Illinois. It has important properties that make it an excellent parent material for productive agricultural soils: it crumbles easily when lightly squeezed, drains well yet has good moisture-holding capacity, and contains no pebbles or cobbles to interfere with plowing. Loess is derived from sediments that were deposited along the major meltwater valleys, such as the Illinois River valley, by sediment-laden meltwater flowing from the melting glaciers to the northeast. Prevailing westerly winds picked up the finer sediments—silt, fine sand, and some clay—from the floodplain and blew them across the landscape. Loess is thickest immediately east of the major valleys and thins rapidly with distance eastward.

Regional Glacial History

Hundreds of records (logs) and samples of sediments from borings drilled throughout the Illinois River Bluffs area are stored and catalogued at the Illinois State Geological Survey. Deep borings that penetrated the entire sequence of glacial sediments overlying bedrock provide the record from which the general glacial history of the region can be interpreted.

Sediments left by the earliest glaciers in this area are buried or partially eroded. These sediments are called "pre-Illinoian" because they predate the well-preserved and well-documented sediments of the Illinois Episode of glaciation. On the bedrock uplands of the assessment area, pre-Illinoian deposits were deeply eroded by the glaciers and are on the bedrock surface within the valleys on the bedrock surface. Thick deposits of pre-Illinoian sand, gravel, and silt do exist, buried especially within the confines of the Ancient Mississippi Bedrock Valley (Figure 4), which served as a major drainageway for meltwaters from pre-Illinois episode glaciers that approached the area from both the northeastern and northwestern centers of ice accumulation in Canada. An especially interesting pre-Illinoian deposit is the Sankoty Sand, a medium-grained sand composed largely of quartz grains, of which many are pink, rounded, and polished (Horberg and others 1950).

The Sankoty Sand, which constitutes an important aquifer throughout much of the region (see Aquifer Delineation section below), was deposited as outwash by the earliest glaciers to enter the region and was probably reworked by meltwaters of subsequent glaciers.

After the earliest glaciations, the Ancient Mississippi River essentially followed, with one exception, the present course of the Illinois Valley south to the confluence with the Ancient Iowa River at Grafton in Jersey County. The exception is the present, very young valley of the Illinois River near Peoria and Pekin, where the Ancient Mississippi Bedrock Valley lies a short distance east of the Peoria-Pekin area. The northern part of this segment of the Ancient Mississippi Bedrock Valley lies within the assessment area along the Woodford-Tazewell County border.

Glaciers of both the Illinois and Wisconsin Episodes of glaciation later overran the assessment area, leaving behind layers of till and outwash across the uplands. Most of the drift that immediately overlies the bedrock upland surface consists of layers of diamicton (a mixture of gravel, sand, silt, and clay commonly referred to as till) and outwash deposited by glaciers of the Illinois Episode. These layers are classified as the Glasford Formation (Willman and Frye 1970). The Glasford is not mapped at the surface in the assessment area because it is overlain by layers of younger diamicton and outwash of the Wisconsin Episode (the most recent glacial episode). The Wisconsin Episode diamicton belongs to either the Tiskilwa or the Lemont Formations of the Wedron Group. The gray, clayey Yorkville Member of the Lemont Formation occurs in the eastern third of the area, and the gray, silty Batestown Member of the Lemont occurs in the center third (Figure 5). The undifferentiated till facies of the Tiskilwa Formation is the surface till along the western third of the area. The Illinois River cuts from northeast to southwest through the area mapped as the Lemont and Tiskilwa Formations. On the uplands away from the valley is 10 to 15 feet or more of loess, classified as Peoria Silt. The loess thins rapidly eastward to 5 feet or less at the easternmost limit of the assessment area (Figure 5).

Meltwater from Illinois and Wisconsin Episode glaciers swept down the Ancient Mississippi Bedrock Valley, leaving outwash deposits behind. These sediments, too, were scoured and reworked by streams and rivers. Today, Wisconsin Episode outwash of the Henry Formation of the Mason Group (Hansel and Johnson 1996) is found along much of the present-day Illinois River valley (Figure 5). In places this outwash has been reworked by wind into fields of sand dunes (informally called the Parkland sand). Some silts and clays deposited in glacial lakes that formed during the Wisconsin Episode glaciation (now classified as the Equality Formation of the Mason Group) occur in areas bordering the Henry Formation (these sediments also occur in patches on uplands west of the Illinois River in the western third of the assessment area). Overlying the outwash in the Illinois River valley is modern-day stream alluvium, classified as Cahokia Alluvium (Willman and Frye 1970).

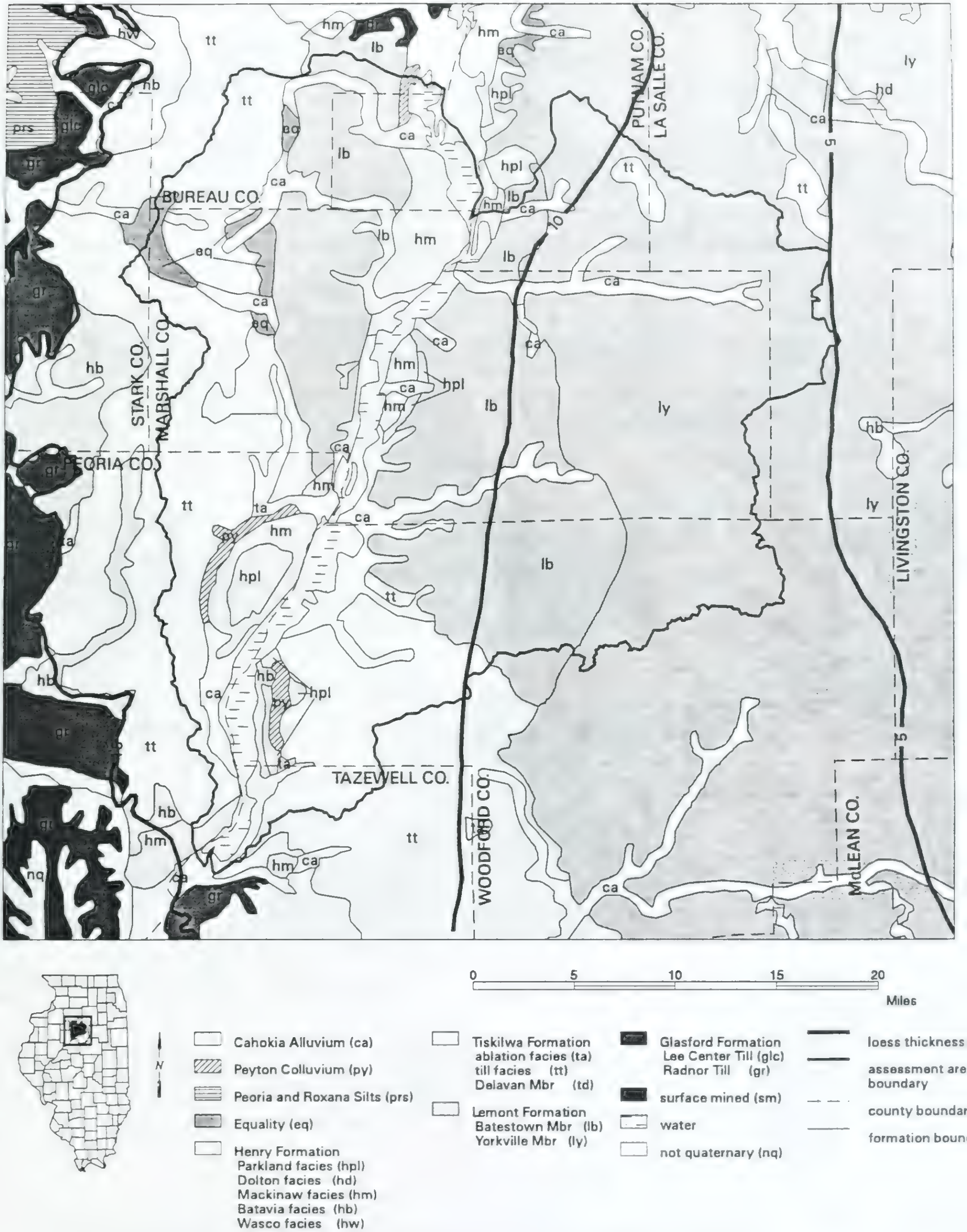


Figure 5. Glacial Geology (modified after Lineback 1979, Hansel and Johnson 1996)

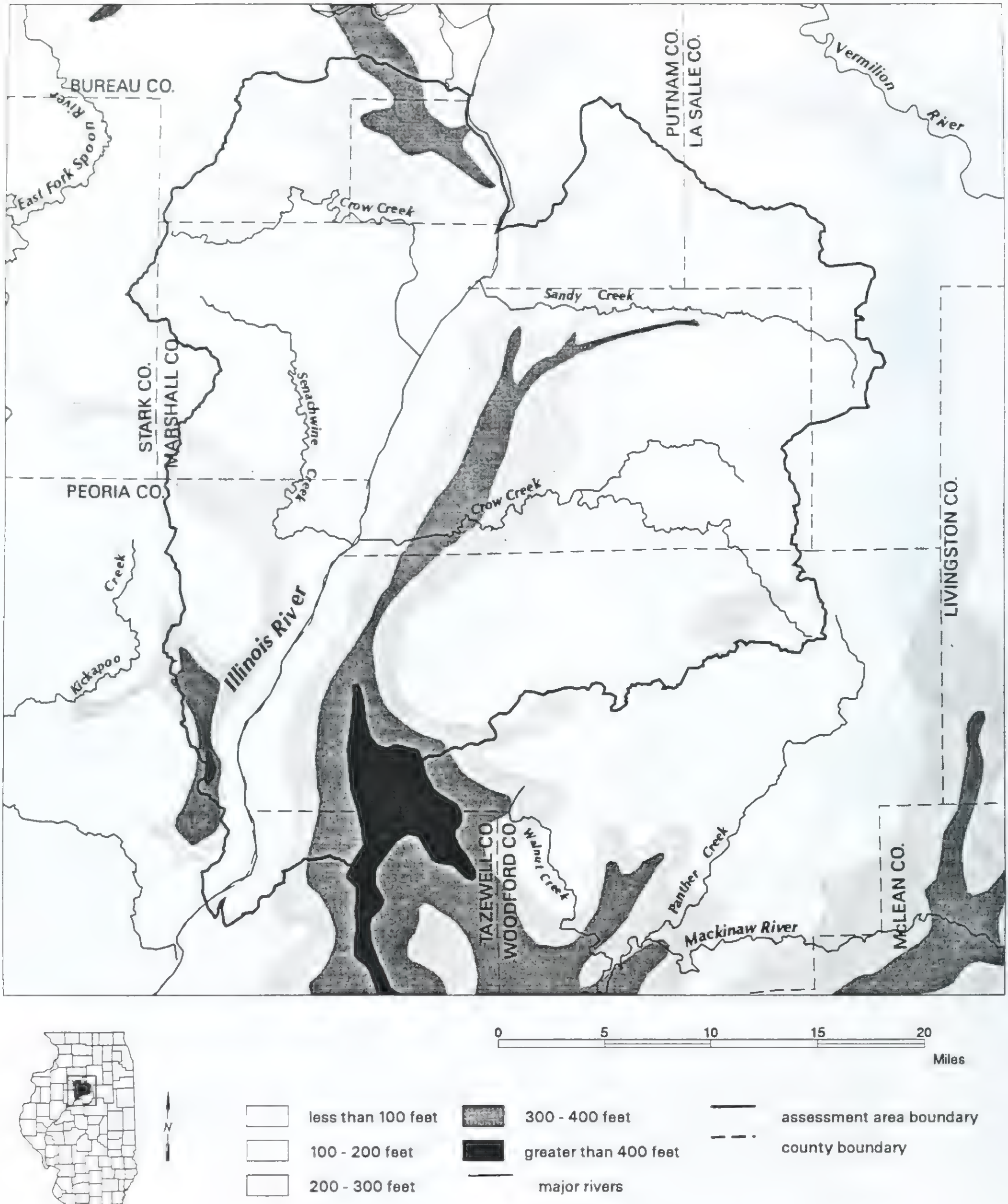


Figure 6. Thickness of Glacial Drift (modified after Piskin and Bergstrom 1975)

Thickness of Materials

Glacial deposits range from less than 100 feet to more than 400 feet thick in the Illinois River Bluffs Assessment Area (Figure 6). In the area of the bedrock uplands, glacial deposits generally range from less than 100 to about 300 feet thick, and areas of thicker drift generally coincide with moraines. Glasford Formation sediments generally account for from one-third to one-half of the drift thickness; Wedron Group sediments generally are thicker and account for one-half to two-thirds of the thickness.

The thickest glacial deposits, which range from 200 to more than 400 feet thick, coincide with the Ancient Mississippi Bedrock Valley (compare Figure 6 with Figure 4) that lies east of and parallel to the present-day Illinois River Valley. Deposits of similar thickness also lie along the southwestern border of the assessment area in eastern Peoria County. In the Ancient Mississippi Valley, the Sankoty Sand is generally up to 200 feet or more thick (Horberg and others 1950).

References

Hansel, A.K., and W.H. Johnson, 1996, Wedron and Mason Groups—Lithostratigraphic Reclassification of Deposits of the Wisconsin Episode, Lake Michigan Lobe Area: Illinois State Geological Survey Bulletin 104, 116 p.; plate 1: Quaternary Deposits of Illinois (map).

Horberg, L., M. Suter, and T.E. Larson, 1950, Groundwater in the Peoria Region: Illinois State Geological Survey Bulletin 75, 128 p.

Lineback, J.A., 1979, Quaternary Deposits of Illinois: Illinois State Geological Survey 1:500,000-scale map.

Piskin, K., and R.E. Bergstrom, 1975, Glacial Drift in Illinois—Thickness and Character: Illinois State Geological Survey Circular 490, 35 p.

Willman, H.B., and J.C. Frye, 1970, Pleistocene Stratigraphy of Illinois: Illinois State Geological Survey Bulletin 94, 204 p.

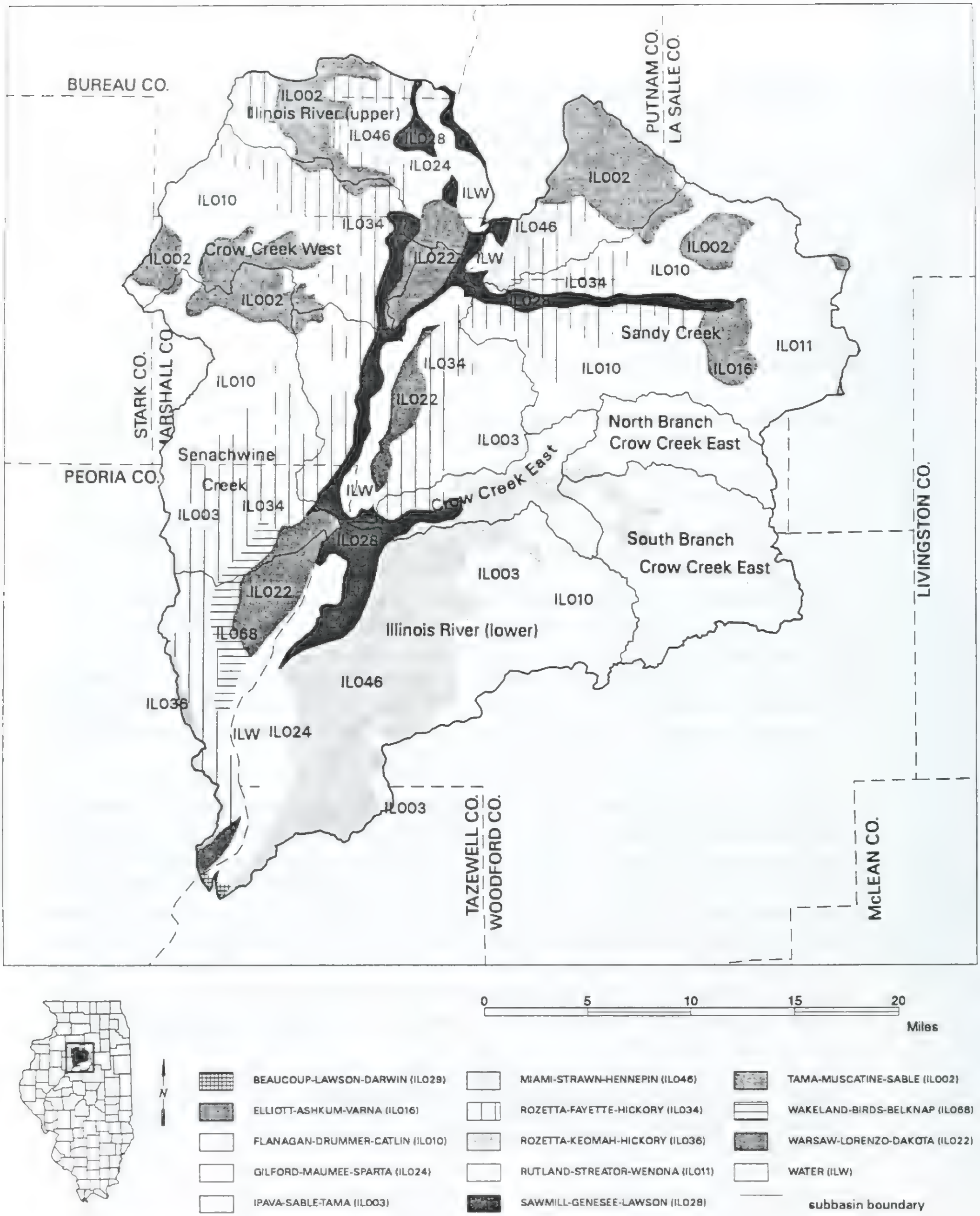
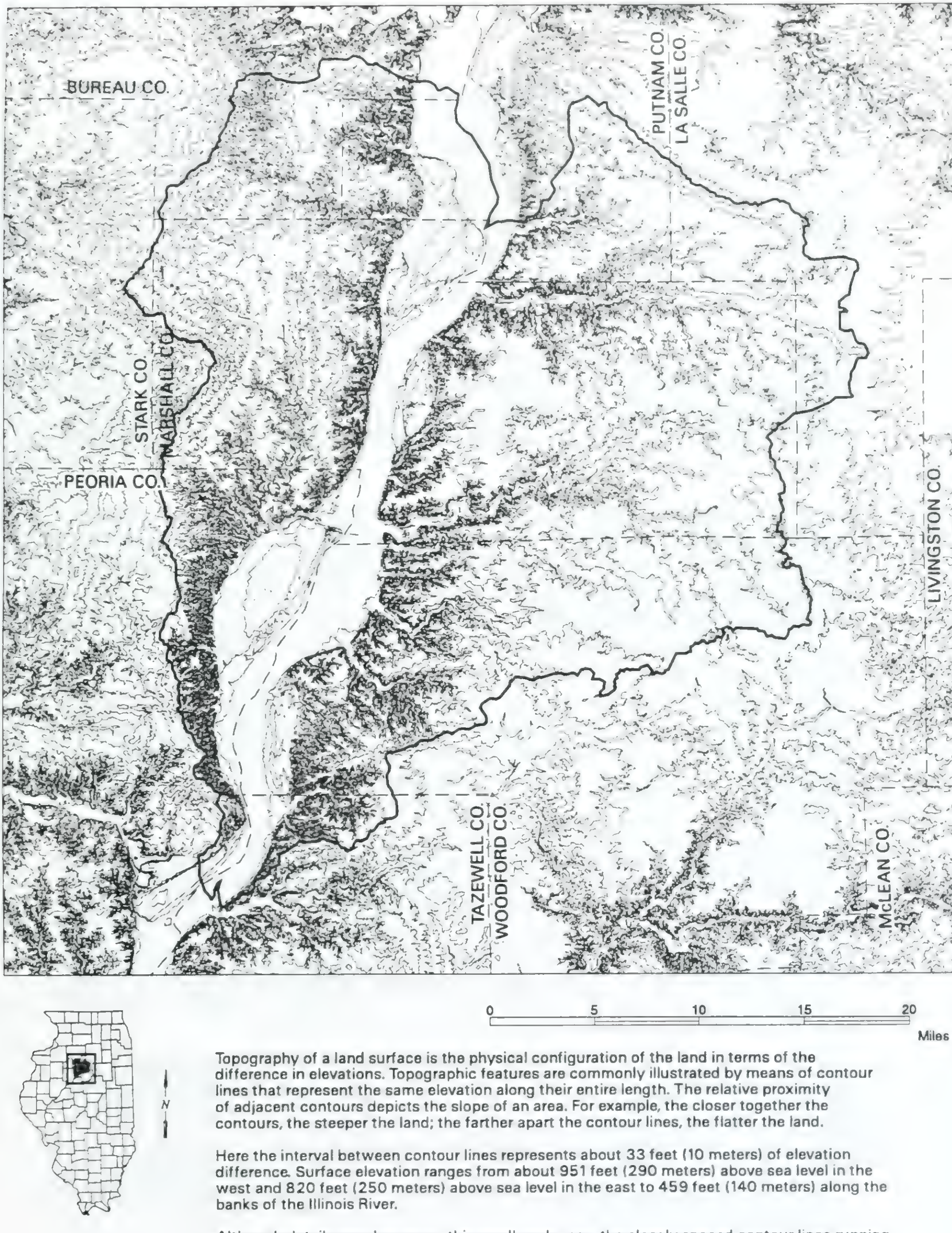


Figure 7. Soil Associations of the Illinois River Bluffs Assessment Area (modified after STATSGO 1994)



Topography of a land surface is the physical configuration of the land in terms of the difference in elevations. Topographic features are commonly illustrated by means of contour lines that represent the same elevation along their entire length. The relative proximity of adjacent contours depicts the slope of an area. For example, the closer together the contours, the steeper the land; the farther apart the contour lines, the flatter the land.

Here the interval between contour lines represents about 33 feet (10 meters) of elevation difference. Surface elevation ranges from about 951 feet (290 meters) above sea level in the west and 820 feet (250 meters) above sea level in the east to 459 feet (140 meters) along the banks of the Illinois River.

Although details are obscure on this small-scale map, the closely spaced contour lines running north and south in the center of the assessment area outline the Illinois River Bluffs on either side of the river. The relatively flat area between the bluffs is the river's floodplain. In some places the floodplain is nearly 8 miles wide.

Figure 8. Topography of Land Surface

Soil Erosion and Sedimentation

The predominance of slopes of less than 4% (4 vertical feet in 100 horizontal feet) attests to the flatness of much of the upland area and lessens the potential for soil erosion there. The general lack of drainage dissection of the flat upland and floodplain areas, however, combined with the slow permeability of the relatively fine-textured underlying sediments, makes for high water tables and wet soils. These areas may be prime wildlife and wetland areas if they have not been cleared for cultivation.

Steeper slopes adjoining the floodplains of the streams are susceptible to severe soil erosion through sheetwash and the development of extensive gully networks. This eroded sediment is generally transported into small local channels and, ultimately, into the larger drainages. Uncontrolled erosion and sedimentation can seriously damage biological communities that live in the channel or along streambanks by altering water tables, channel capacity, and channel geometry.

The extensive distribution and thickness of loess across the assessment area further contributes to the erosion hazard. Loess is easily picked up (entrained) and carried by moving water or wind. When dry, loess has the consistency of talcum powder and, if unprotected, is easily carried by wind. Loess is also particularly susceptible to erosion by running water because of its low shear resistance. It is rapidly incised and develops into a deeply dissected landscape characterized by rills and gullies that are difficult to control. On topographic maps, this characteristic drainage pattern is shown as highly crenulated (sinuous) topographic contour lines (see Figure 8). Where loess overlies less permeable geologic materials such as fine-textured tills, the contrast in permeability and erodibility creates problems in land management, especially where the overlying loess unit is dissected or eroded and the less permeable underlying materials are exposed at or near the land surface.

Further increasing the erodibility of loess is the tendency for piping to develop within the soil. Piping is common when surface water penetrates to the subsurface and flows along macropores, such as open channels formerly occupied by roots, or along other natural fractures in the ground. These linear "pipes" may enlarge and ultimately collapse, causing the ground surface to subside and form small surface drainage channels. These channels then begin to collect and transport sediment and water as they are integrated into the local drainage system.

Sloping, forested soils are especially susceptible to piping and are where hillside gullies often begin, even when the ground surface has not been disturbed by deforestation or cultivation. Once begun, these small rills and gullies can quickly enlarge and erode upstream, extending the drainage network and directing increased water and sediment into the existing drainage system. The increased water and sediment discharge can initiate streambank erosion and streambed changes that are detrimental to the biological communities that inhabit the stream channels.

The extensive areas with grassland and forested land cover (Figures 13 and 14) remaining in the Illinois River Bluffs Assessment Area indicate the difficulty of cultivating the more dissected and eroded landscape along the steeper topography associated with major drainageways and moraines. These grassland and forested areas make up much of the existing prime wildlife habitat in the region. Most of the eroded soils in the assessment area are located on slopes adjacent to stream channels, especially along the larger tributaries. The increase in slope angle and slope length in these areas creates a high potential for erosion. Because of their topographic position, low wetland areas commonly receive accelerated deposition of sediment eroded from adjacent upland areas that have been in, or are currently in, cultivation or are in transition from undisturbed natural vegetation. This inundation of sediment can degrade wildlife food supplies and fill stream channels, decreasing their capacity to transport water and increasing the frequency of discharges of floodwater over the banks of streams. Pools along the streams are especially prone to damage from sedimentation. Pesticides and other agricultural chemicals adsorbed to the sediment may also be deposited in channels and pools.

The physical load of sediment can accumulate quickly enough to bury part of the modern soil. Buried modern soils can be seen in some vertical soil profiles exposed along stream courses where a dark-colored former soil horizon lies beneath recently deposited, lighter-colored sediments. Such buried modern soils are evidence of accelerated erosion resulting from human activity and are environmental indicators of current and potential problems in a drainage system.

Land Management Practices

Sound land use and management practices are especially important in controlling erosion on loessial soils. Damaged land should quickly be remediated and appropriate erosion control measures should be implemented to prevent additional damage to the landscape. It is unlikely that severe erosion caused by gullying on hillslopes will repair itself quickly enough to prevent extensive damage to adjacent land. Gullies developing in loess can quickly become too deep for farm equipment to cross and eliminate through tillage. Farming along narrow ridgetops is generally not advisable due to the lack of transition zones along field edges to keep water from running off the field and entering hillside drainage channels.

The moderately slow permeability of many of the soils in the assessment area creates conditions conducive to standing water during periods of high water table or heavy precipitation. Some of the soils in the assessment area respond well to tiling; however, field drainage has increased the volume and rate of runoff from cultivated fields. The increased stream discharge that results from tiling, however, can cause additional erosion problems through channel widening and bank failure along many of the drainages.

In summary, the potential for erosion and the slow permeability of soil are the major management problems faced by land users in this area. The many potential problems created

by the predominance of silty soil and variable topography can be alleviated by appropriate conservation tillage practices and tiling.

County Soil Survey Reports

The Illinois River Bluffs Assessment Area covers parts of eight counties, with most of the area in Peoria, Woodford, and Marshall Counties. With the exception of La Salle County (report published in 1972), the assessment area is covered by modern soil surveys completed since 1975. The Woodford County report is awaiting publication, but the information from this report may already be available by contacting the Natural Resources Conservation Service (NRCS) office in that county. Digital soil surveys of Bureau and Marshall Counties are planned for release soon. Using the appropriate software, these digital products can provide increased versatility in applying soil characteristics in environmental planning. As always, individuals or groups seeking to plan environmental restoration or conservation projects should contact local federal, state, and county offices to determine the nature of the soils and consult other appropriate environmental databases. The maps presented in this assessment report are too small in scale (not detailed enough) to provide for more than a cursory or reconnaissance level of interpretation. They are for general planning and information purposes only.

County soil survey reports are increasingly being updated and converted to digital format. Although this process will take some years to complete, interested individuals and groups should check with their local NRCS agent to learn what materials and information are available for their specific location. The individual soil maps presented in each county soil survey report are published at a scale of 1:15,840, or 1 inch equals 1,320 feet (0.25 miles). A smaller-scale soil association map is also included, usually at a scale of about 1:250,000, or 1 inch equals about 4 miles. The scale of the soil association map is too small (contains too little detail) for site specific planning and analysis, but the individual soil sheets are ideal for this purpose. Even these maps, however, lack the detail necessary for specific site assessments for construction, but they are valuable for most environmental-scale planning.

The large-scale soil maps in county soil survey reports are valuable sources of information regarding local conditions. Tabulated information within the report summarizes the capabilities and limitations of each soil series for various land uses as well as its physical and chemical characteristics. There are also tables with information concerning the suitability and capability of soils for supporting wildlife and woodland habitats.

References

Alexander, J.D., and R.G. Darmody, 1991, Extent and Organic Matter Content of Soils in Illinois Soil Associations and Counties: Department of Agronomy, College of Agriculture, University of Illinois at Urbana Champaign, Agronomy Special Report 1991-03, 64 p.

Alexander, J.D., and J.E. Paschke, 1972, Soil Survey of La Salle County, Illinois: U.S. Department of Agriculture, Soil Conservation Service, and Illinois Agricultural Experiment Station, University of Illinois at Urbana-Champaign, 140 p.

Fehrenbacher, J.B., J.D. Alexander, I.J. Jansen, R.G. Darmody, R.A. Pope, M.A. Flock, E.E. Voss, J.W. Scott, W.F. Andrews, and L.J. Bushue, 1984, Soils of Illinois: University of Illinois at Urbana-Champaign, Agricultural Experiment Station Bulletin 778, 85 p.

Fehrenbacher, J.B., I.J. Jansen, and K.R. Olson, 1986, Loess Thickness and Its Effect on Soils in Illinois: University of Illinois at Urbana-Champaign, Agricultural Experiment Station Bulletin 782, 14 p.

Hansel, A.K., and W.H. Johnson, 1996, Wedron and Mason Groups—Lithostratigraphic Reclassification of Deposits of the Wisconsin Episode, Lake Michigan Lobe Area: Illinois State Geological Survey Bulletin 104, 116 p.; plate 1: Quaternary Deposits of Illinois (map).

United States Department of Agriculture, 1994, State Soil Geographic (STATSGO) Data Base. Data Use Information: Soil Conservation Service, National Soil Survey Center Misc. Publication No. 1492. 33 p.

Walker, M.B., 1992, Soil Survey of Peoria County, Illinois: U.S. Department of Agriculture, Soil Conservation Service, and Illinois Agricultural Experiment Station, University of Illinois at Urbana-Champaign, 225 p.

Wascher, H.L., J.D. Alexander, B.W. Ray, A.H. Beavers, and R.T. Odell, 1960, Characteristics of Soils Associated with Glacial Tills in Northeastern Illinois: University of Illinois at Urbana-Champaign, Agricultural Experiment Station Bulletin 665, 155 p.

Wascher, H.L., B.W. Ray, J.D. Alexander, J.B. Fehrenbacher, A.H. Beavers, and R.L. Jones, 1971, Loess Soils of Northwest Illinois: University of Illinois at Urbana-Champaign, Agricultural Experiment Station Bulletin 739, 112 p.

Zwicker, S.E., 1992, Soil Survey of Putnam County, Illinois: U.S. Department of Agriculture, Soil Conservation Service, and Illinois Agricultural Experiment Station, University of Illinois at Urbana-Champaign, 168 p.

Landscape Features and Natural Areas with Geologic Features of Interest

The landscape features of the Illinois River Bluffs Assessment Area were formed by processes associated primarily with successive glacial advances across the area, and this is reflected in the physiography of the region. The assessment area falls entirely within the physiographic division called the Bloomington Ridged Plain (Figure 9), a subdivision of the Till Plains Section of the Central Lowland Province (Leighton and others 1948). The "ridged plain" refers to the succession of end moraines that arc across the land surface and that were constructed by the Wisconsin Episode glacier as it gradually retreated into the Lake Michigan basin. In the Illinois River Bluffs area, the moraines trend generally in a north–south to northwest–southeast direction, but a few arc nearly west to east. The Illinois River Valley (Figure 5) forms a major breach in the pattern of moraines across the assessment area.

The landscape can also be characterized as uplands and lowlands connected by slopes. Uplands are the extensive regions of higher ground, including the area of end moraines and ground moraine, on either side of the Illinois River Valley. General elevations on these uplands range from more than 800 feet to approximately 650 feet above mean sea level (Figure 8). Slopes from the uplands to the lowlands range in elevation from about 650 to 500 feet. Lowlands refer to areas lying at elevations of 500 feet or less along valleys, such as floodplains and similar areas of alluvial deposition. In the assessment area, these occur primarily in the floodplain of the Illinois River Valley and its tributaries, such as Sandy Creek and Crow Creek.

Natural Areas with Geologic Features of Interest

According to Illinois Natural History Survey records (Illinois Natural Areas Inventory 1978), four natural areas in or near the borders of the Illinois River Bluffs Assessment Area contain features of geologic interest. The first of these, Farm Creek Geological Area, is on private land in Tazewell County about 4 miles east of the Illinois River; it contains an outstanding 90-foot-high exposure of sediments from the last two major glaciations to affect the area and early soils developed in warmer intervals between glaciations. It was recently designated a national historic site because of its importance in the history of geologic studies of North Amnerica. On the east side of the Illinois River bluffs in Putnam County is a natural area named Magnolia Hill Prairie. On private land, this natural area contains an excavation in glacial drift. The last two natural areas are located in Peoria County: Rocky Glen and Jubilee State Park. Rocky Glen, partly on private land and partly on public land, boasts a waterfall in a canyon in Pennsylvanian bedrock; it is located approximately 3 miles west of the Illinois River. Jubilee State Park, on public land west of the river, contains an outcrop of Pennsylvanian bedrock that consists of shale and sandstone.

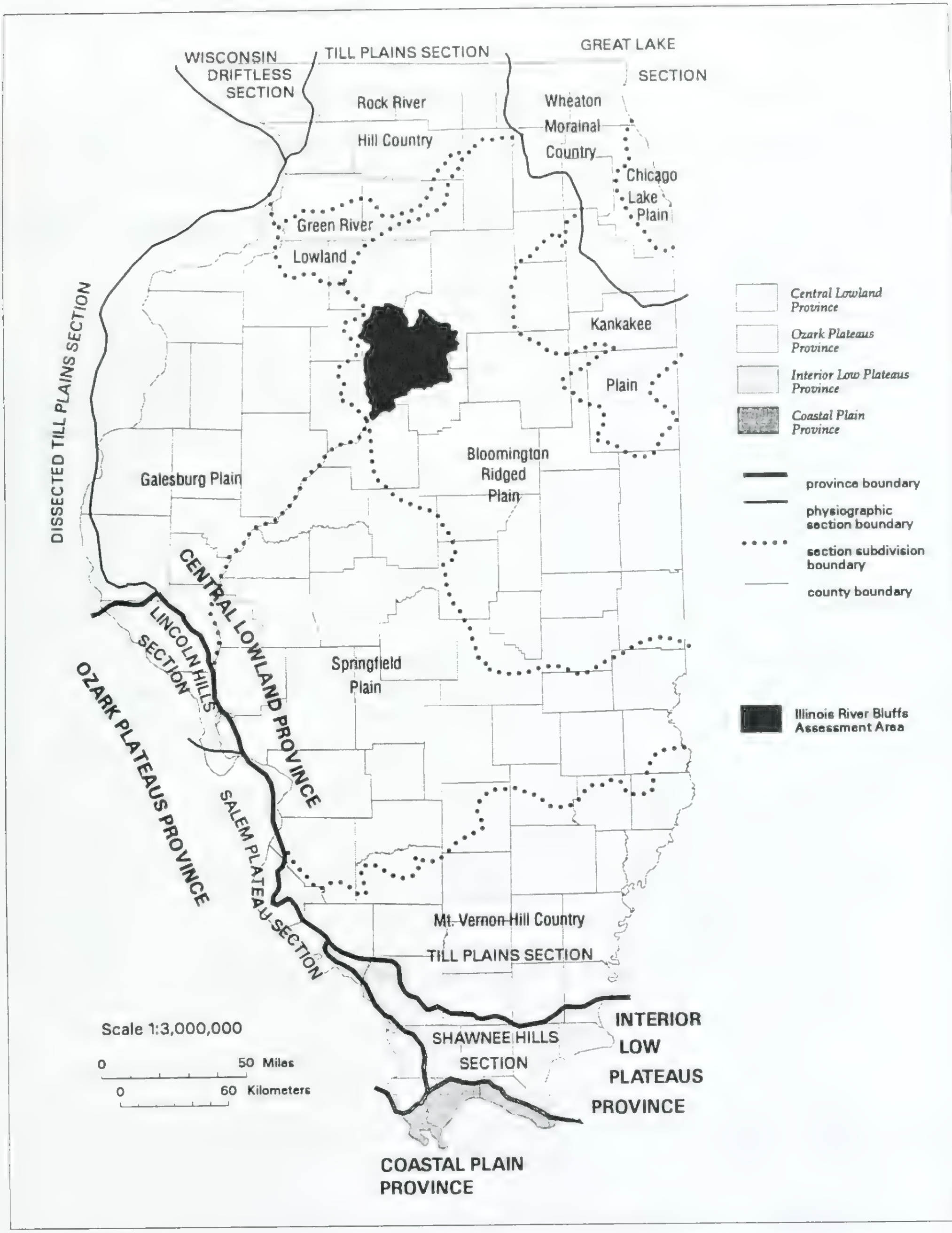


Figure 9. Physiographic Divisions of Illinois (from Leighton, Ekblaw, and Horberg 1948)

References

Illinois Natural Areas Inventory, 1978, Department of Landscape Architecture, University of Illinois at Urbana-Champaign, and Natural Land Institute, Rockford, IL, 3 vols.

Leighton, M.M., G.E. Ekblaw, and C.L. Horberg, 1948, Physiographic Divisions of Illinois: Illinois State Geological Survey Report of Investigations 129, 19 p.

Land Cover Inventory

Introduction

Land is the "raw material" of Illinois. Current and detailed information regarding this fundamental natural resource is essential for making wise decisions affecting the land and ensuring good stewardship. Land can be described in terms of a number of biological, geological, and hydrological characteristics. This section focuses on *land cover*, a principal factor for describing a region's land resource. The following paragraphs introduce and explain some basic concepts.

Land use refers to human activities on the land and emphasizes the principal role of land in describing a region's economic activities. Since the concept describes human activity, land use is not always directly observable; that is, we commonly cannot "see" the specific use of a parcel of land. For example, the presence of forested land in an aerial photograph or satellite image does not convey the possible multiple uses of that land, which may include recreation, wildlife refuge, timber production, or residential development.

Land cover refers to the vegetation and manmade features covering the land surface, all of which can be directly observed using remote sensing imagery.[1] Whereas land use is abstract, land cover is tangible and can be determined by direct inspection of the land surface; it is the visible evidence of land use (Campbell 1987).

In association with other geologic data (such as aquifer location, distribution of water wells, and soil characteristics), geologists can use land cover and land use maps to infer geologic conditions in an area. For example, knowledge of land cover (such as location and extent of urban lands and cropland) is essential to accurately assessing the potential for groundwater contamination. Land cover information is also important for resource conservation. In areas where natural vegetation predominates, land cover maps can be used as substitutes for ecosystem maps in conservation evaluation because vegetation effectively integrates many physical and biological factors in a geographic area (Scott 1993).

Remote Sensing Products

Land use and land cover maps are derived directly from remote sensing imagery. Geologists use a variety of data sources to derive information concerning surface and near-surface

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[1] Remote sensing is the science of deriving information about an object or phenomenon at or near the surface of the earth through the analysis of data acquired by a camera or sensor system located in an aircraft or orbiting satellite.

conditions, and the usefulness of remote sensing imagery for mapping geologic features has been long recognized (USGS 1994).

For assessments at the site level (for example, sample sites or plots) or small regions (for example, county-level), land cover information is typically derived from the interpretation of aerial photography. At the statewide level, land cover information is usually derived from the analysis of satellite imagery, and the resulting inventory offers accurate, regional-level information regarding surface cover characteristics.

Although agricultural lands dominate three-fourths of the surface of Illinois, and many landscape features have been obscured as a result of 175 years of European settlement, remote sensing imagery can show subtle changes in the uppermost few feet of materials and is often more detailed than soils maps. Aspects of biodiversity associated with resource quality, richness, and quantity can be estimated with remotely-sensed data, principally because the remote sensing approach compares changes in land use over time (Stoms and Estes 1993).

In 1996, the Illinois Department of Natural Resources published *Illinois Land Cover: An Atlas* (IDNR 1996) and *Illinois Land Cover: An Atlas on Compact Disc* (IDNR 1996), which present the most recent and comprehensive inventory of the state's surface cover. Multitemporal, Landsat Thematic Mapper satellite imagery acquired during 1991–1995 was the principal data source. All of the land cover information presented in this section is derived from *Illinois Land Cover: An Atlas on Compact Disc.*

Land Cover Inventory of the Illinois River Bluffs Assessment Area

The Illinois River Bluffs Assessment Area encompasses a surface area of 876 square miles (560,876.5 acres) and incorporates portions of Bureau, La Salle, Marshall, Putnam, Peoria, Stark, Tazewell, and Woodford Counties (Figure 1). The assessment area comprises eight adjoining subbasins ranging in size from 30.4 square miles (19,480 acres) (North Branch Crow Creek East Subbasin) to 324.8 square miles (207,849 acres) (Illinois River [lower] Subbasin) (Figure 10).

The type and extent of land cover in the Illinois River Bluffs Assessment Area is presented in Table 1. Landsat Thematic Mapper satellite imagery acquired on June 13, 1992, October 3, 1992, and May 15, 1993, was used as the primary data source for the compilation of the land cover information for the assessment area (IDNR 1996). For purposes of comparison, a statewide summary of land cover is provided in Table 2. In addition, Appendix B provides an inventory of land cover types for each subbasin, wherein the original 18 categories shown in Table 1 have been consolidated to 9 principal land cover categories in order to facilitate subbasin comparisons (compare Tables 2 and 3). To better visualize the spatial relationships of land cover type and subbasin position, Figures 12–17 are maps representing these principal land cover categories. The reader should be advised that in order to accommodate the standardized, small-scale map format used for the assessment

Table 1. Land Cover of the Illinois River Bluffs Assessment Area*

Category	*Sq. Mi.*	*Acres*	*%Area*
Agricultural Land	**649**	**415,061**	**74.0**
Row Crops	495	316,717	56.5
Small Grains	26	16,491	2.9
Rural Grassland	128	81,852	14.6
Orchards & Nurseries	0	1	0.0
Forest & Woodland	**119**	**76,068**	**13.6**
Deciduous closed canopy	111	71,016	12.7
Deciduous open canopy	8	4,834	0.9
Coniferous	0	218	0.0
Urban & Built-Up Land	**28**	**17,845**	**3.2**
High Density	3	1,833	0.3
Medium Density	3	2,058	0.4
Low Density	6	3,583	0.6
Transportation	7	4,547	0.8
Urban Grassland	9	5,824	1.0
Wetland	**51**	**32,432**	**5.8**
Shallow Marsh/Wet Meadow	2	1,448	0.3
Deep Marsh	1	581	0.1
Forested	21	13,213	2.4
Open Water Shallow	27	17,190	3.1
Other Land	**30**	**19,470**	**3.5**
Open Water Deep	30	19,237	3.4
Barren & Exposed	0	233	0.0
Totals	**876**	**560,877**	**100.0**

*Small errors in totals are due to rounding

report, the scale and categorical resolution of the original land cover inventory data have been reduced. However, all of the statistical information have been derived using the original Land Cover of Illinois database. Figure 11 is a composite land cover map of the southeastern portion of the Illinois River Bluffs Assessment Area and is an example of the improved detail that is available within the statewide land cover inventory.

Agricultural land use dominates the region and accounts for nearly three-fourths (74%, or 415,061 acres) of the Illinois River Bluffs Assessment Area. By comparison, approximately three-fourths (77.5%) of Illinois' surface area is agricultural land (Table 2). Of the two principal land cover categories that comprise Agricultural Land, Cropland alone (row crops, small grains, and orchards/nurseries) constitutes most of the agricultural land use, accounting for almost 60% (59.4%, or 333,209 acres) of the total surface of the assessment area (Table 3 and Figure 12). Only exceeded by Cropland in occurrence, Rural Grassland

Table 2. Land Cover of Illinois (IDNR 1996)*

Category	*Sq. Mi.*	*Acres*	*%Area*
Agricultural Land	**43,639**	**27,928,797**	**77.5**
Row Crops	30,600	19,584,247	54.3
Small Grains	3,166	2,026,268	5.6
Rural Grassland	9,848	6,302,371	17.5
Orchards & Nurseries	25	15,911	0.0
Forest & Woodland	**6,389**	**4,088,623**	**11.32**
Deciduous closed canopy	5,618	3,595,538	10.0
Deciduous open canopy	658	421,013	1.0
Coniferous	113	72,072	0.2
Urban & Built-Up Land	**3,262**	**2,087,396**	**5.8**
High Density	477	305,065	0.8
Medium/High Density	187	119,352	0.3
Medium Density	730	466,894	1.3
Low Density	393	251,180	0.7
Transportation	492	314,866	0.9
Urban Grassland	84	630,038	1.8
Wetland	**1,829**	**1,170,550**	**3.2**
Shallow Marsh/Wet Meadow	220	140,664	0.4
Deep Marsh	55	34,855	0.1
Swamp	18	11,726	0.0
Forested	1,264	808,987	2.2
Open Water Shallow	272	174,318	0.5
Other Land	**1,229**	**786,361**	**2.2**
Open Water Deep	1,203	770,183	2.1
Barren & Exposed	25	16,178	0.1
Totals	**56,347**	**36,061,727**	**100.0**

*Small errors in totals are due to rounding

(pastureland, grassland, waterways, etc.) accounts for the remaining 14.6% (211,364 acres) of the assessment area (Figure 13) in agricultural cover.

A comparison by subbasin shows that land devoted to agricultural use varies from a minimum of 56.3% (41.8% Cropland and 14.4% Rural Grassland) in the Illinois River (lower) Subbasin to the maximum of 96.7% (88.0% Cropland and 8.8% Rural Grassland) in the South Branch Crow Creek East Subbasin. The overwhelming predominance of land devoted to agricultural uses in this subbasin reflects the shallow, limited dissection of the land surface; such a landscape is conducive to large extents of uninterrupted Cropland.

Table 3. Principal Land Cover of the Illinois River Bluffs Assessment Area*

Category	*Sq. Mi.*	*Acres*	*%Area*
Agricultural Land	**649**	**415,061**	**74.0**
Cropland	521	333,209	59.4
Rural Grassland	128	81,852	14.6
Forest & Woodland	**119**	**76,068**	**13.6**
Urban & Built-Up Land	**28**	**17,845**	**3.2**
High Density	19	12,021	2.1
Urban Grassland	9	5,824	1.0
Wetland	**51**	**32,432**	**5.8**
Forested	21	13,213	2.4
Nonforested	30	19,219	3.4
Other Land	**30**	**19,470**	**3.5**
Lakes & Streams	30	19,237	3.4
Barren & Exposed	0	233	0.0
Totals	**876**	**560,877**	**100.0**

*Small errors in totals are due to rounding

Figure 12 shows that, with the exception of the Illinois River (upper and lower) Subbasins, land devoted to agricultural use is nearly 80% or more of the total surface area of each subbasin. Therefore, the potential for nonpoint pollution sources arising from use of agrichemicals, build-up of nitrates from livestock wastes, or increased sediment loads due to erosion is high and should be investigated more closely at the subbasin level.

Forest and Woodland land cover composes 13.6% (76,0689 acres) of the Illinois River Bluffs Assessment Area (Table 3 and Figure 14). Most of this land cover is associated with steep, valley-side slopes adjoining the Illinois River floodplain and valleys directly tributary to the Illinois River (such the Crow Creek, Senachwine Creek, and Sandy Creek Subbasins). The largest and most contiguous area of forested cover is situated in the south-western part of the Illinois River (lower) Subbasin (Figures 10 and 14), associated with the well-defined bluff demarcating a former meander of the Ancient Mississippi River when it occupied this portion of the present-day channel of the Illinois River. Whereas 21.1% of the surface area of the Illinois River (lower) Subbasin is comprised of Forest and Woodland land cover, this single subbasin accounts for 57.6% (43,803 acres) of the total amount of forested land within the assessment area.

Wetland covers 5.8% of the assessment area (Table 3 and Figure 15). Of the 76,068 acres of Wetland cover, nearly 40% (38.7%, or 29,4445 acres) is concentrated in the Illinois River (upper and lower) Subbasins. A primary difference between these two subbasins is that most of the Wetland cover in the Illinois River (upper) Subbasin is characterized by Forested Wetland, whereas the Illinois River (lower) Subbasin is characterized by Non-forested Wetland (Appendix B). Nearly two-thirds (63.7%, or 16,617 acres) of Nonforested

Wetland in the Illinois River (lower) Subbasin is classified as shallow-water habitat and is comprised almost entirely of Upper Peoria Lake and Peoria Lake. Adverse impacts due to sedimentation from nonpoint agricultural sources and adjacent urban development are a major concern for this large area of shallow-water habitat.

Urban and Built-Up Land composes only 3.18% (17,845 acres) of the assessment area (Table 3, Figure 16). Built-Up Land (commercial buildings, residential housing, roadways) composes two-thirds of the total of nearly 18,000 acres, while the remaining one-third is Urban Grassland, which is defined as open space (parks, residential lawns, golf courses, etc.) incorporated within urbanized areas. Locally, the Illinois River (lower) Subbasin accounts for 67.6% (12,066 acres) of the total amount of Urban & Built-Up Land. Whereas land devoted to urban uses is not a significant percentage of the assessment area, the metropolitan area of Peoria is immediately adjacent to, and is partially incorporated within, the Illinois River (lower) Subbasin. Therefore, the potential for adverse impacts to the natural cover, drainage (Figure 17), and groundwater needs to be evaluated in this part of the Illinois River Bluffs Assessment Area.

Notes on Land Cover Maps

In addition to *Illinois Land Cover: An Atlas* (IDNR 1996), two other publications relating to the statewide land cover inventory are available from the Illinois Department of Natural Resources: (1) *Illinois Land Cover: An Atlas on Compact Disc* (IDNR 1996), which contains the statewide land cover digital database; and (2) *Land Cover of Illinois* (IDNR 1996), a printed 1:500,000-scale map. All are available through DNR Conservation 2000 Publications (524 South Second Street, Springfield, IL 62701-1787; telephone: 217-782-7940). Land cover information and data are also available through the DNR website at

http://dnr.state.il.us/ctap/landmap.htm

It is useful to discuss appropriate mapping scales that should be used as guidelines with applications involving the statewide land cover database. Using standardized map scales and associated National Map Accuracy Standards (NMAS) established by the U.S. Geological Survey, maps developed from the land cover database can range from 1:62,000 (1 inch = 1 mile) to 1:100,000 (1 inch = 1.6 miles) and still maintain NMAS standards for raster data possessing a ground spatial resolution of 28.5 meters (93.5 feet). Of course, any smaller-scale maps (for example, 1:250,000) will also maintain NMAS accuracy standards. Given these guidelines, the Illinois Land Cover database can support regional applications but should not be expected to fulfill the needs of site-specific projects.

The maps reproduced in this volume are small-scale versions of preliminary work maps used by the authors in preparation of their sections. The level of detail in these maps is limited by the page size and type and quality of printing available for the reproduction of this report. In general, these maps are suitable for general planning and information

purposes. Higher-detail and higher-resolution maps suitable for more specific applications and assessments can be consulted or obtained by contacting the authors at the Illinois State Geological Survey.

References

Campbell, J.B., 1987, Introduction to Remote Sensing: The Guilford Press, New York, 551 p.

Illinois Environmental Protection Agency, 1994, Illinois Water Quality Report, 1992–1993, Volume II: IEPA Bureau of Water, Springfield, IL, 181 p.

Illinois Land Cover—An Atlas, 1996: Illinois Department of Natural Resources, Springfield, Illinois, IDNR/EEA-96/05, 157 p.

Illinois Land Cover—An Atlas on Compact Disc, 1996: Illinois Department of Natural Resources, Springfield, Illinois.

Landcover of Illinois, 1996: Illinois Department of Natural Resources, Springfield, Illinois, Illinois Scientific Surveys Joint Report 3; 1:500,000-scale map.

Scott, J.M., F. Davis, B. Csuti, R. Noss, B. Butterfield, C. Groves, H. Anderson, S. Caicco, F. D'Erchia, T.C. Edwards, Jr., J. Ulliman, and R.G. Wright, 1993, Gap Analysis—A Geographic Approach to Protection of Biological Diversity, Wildlife Monograph, No. 123, 41 p.

Stoms, D.M., and J.E. Estes, 1993, A Remote Sensing Research Agenda for Mapping and Monitoring Biodiversity: International Journal of Remote Sensing, v. 14, p. 1839–1860.

United States Geological Survey, 1994, Airborne Remote Sensing for Geology and the Environment—Present and Future, K. Watson and D.H. Knepper (eds.): USGS Bulletin 1926, 43 p.

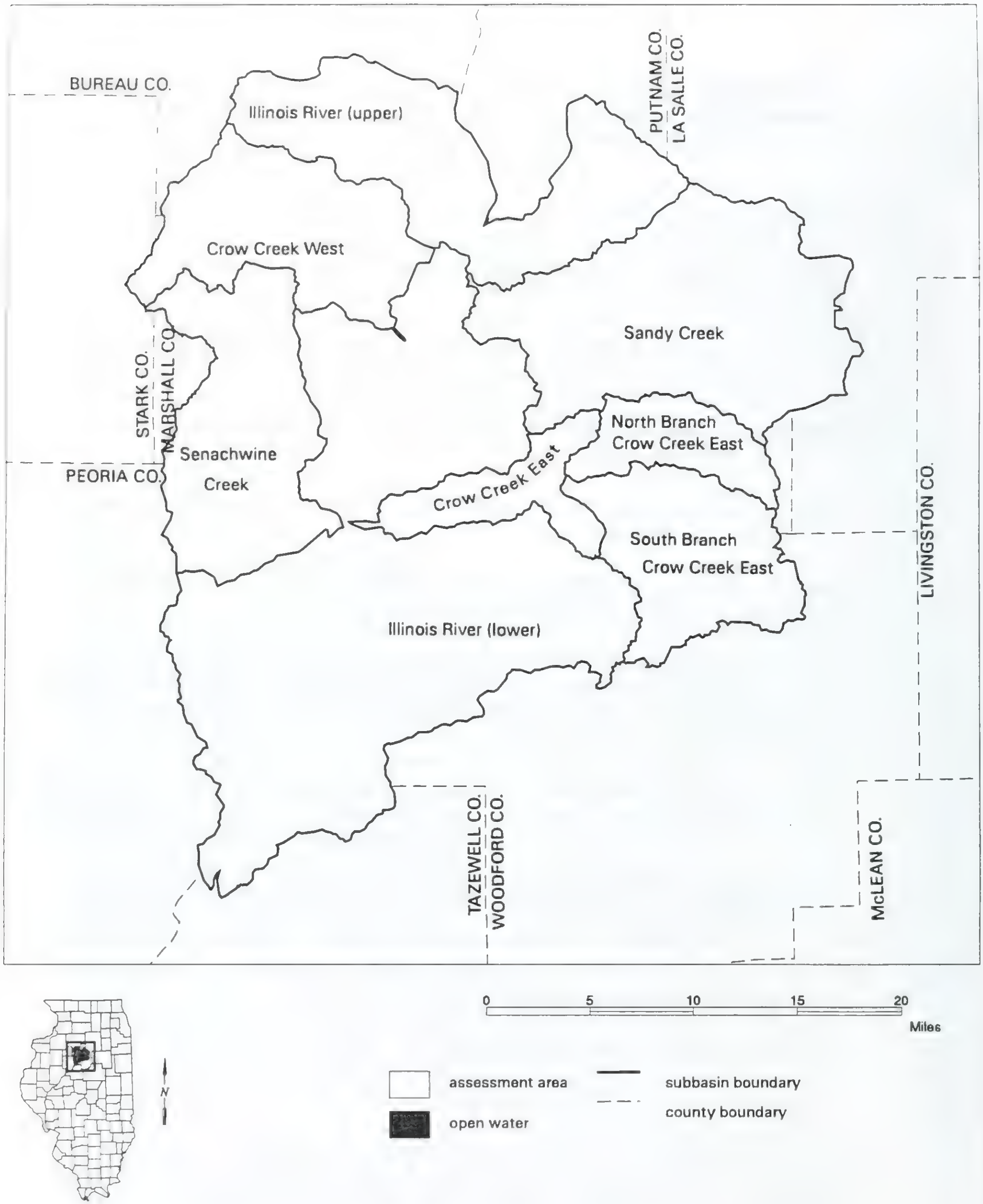

Figure 10. Subbasins of the Illinois River Bluffs Assessment Area

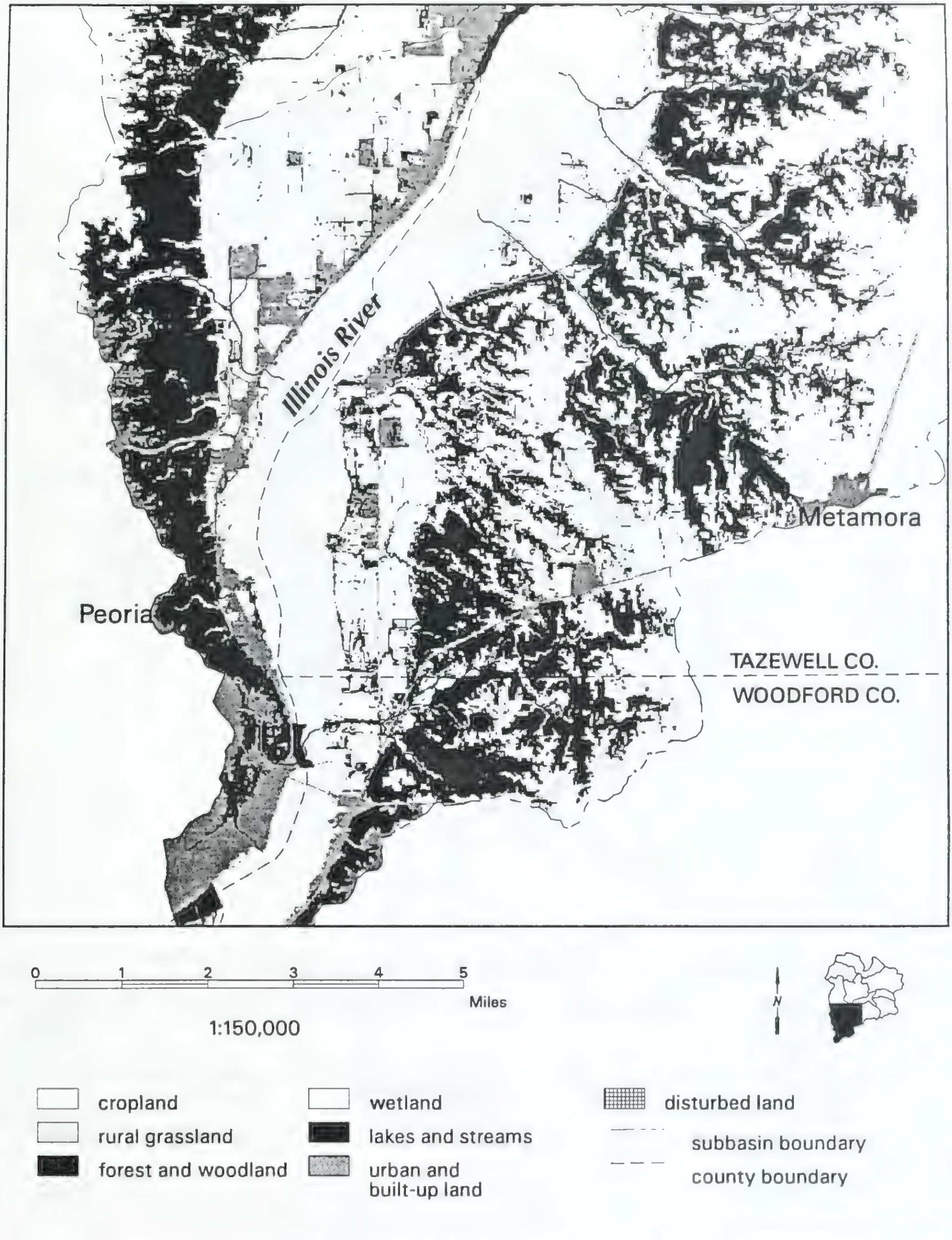

Figure 11. Composite Land Cover Map Centered on the Illinois River (lower) Subbasin (IDNR 1996)

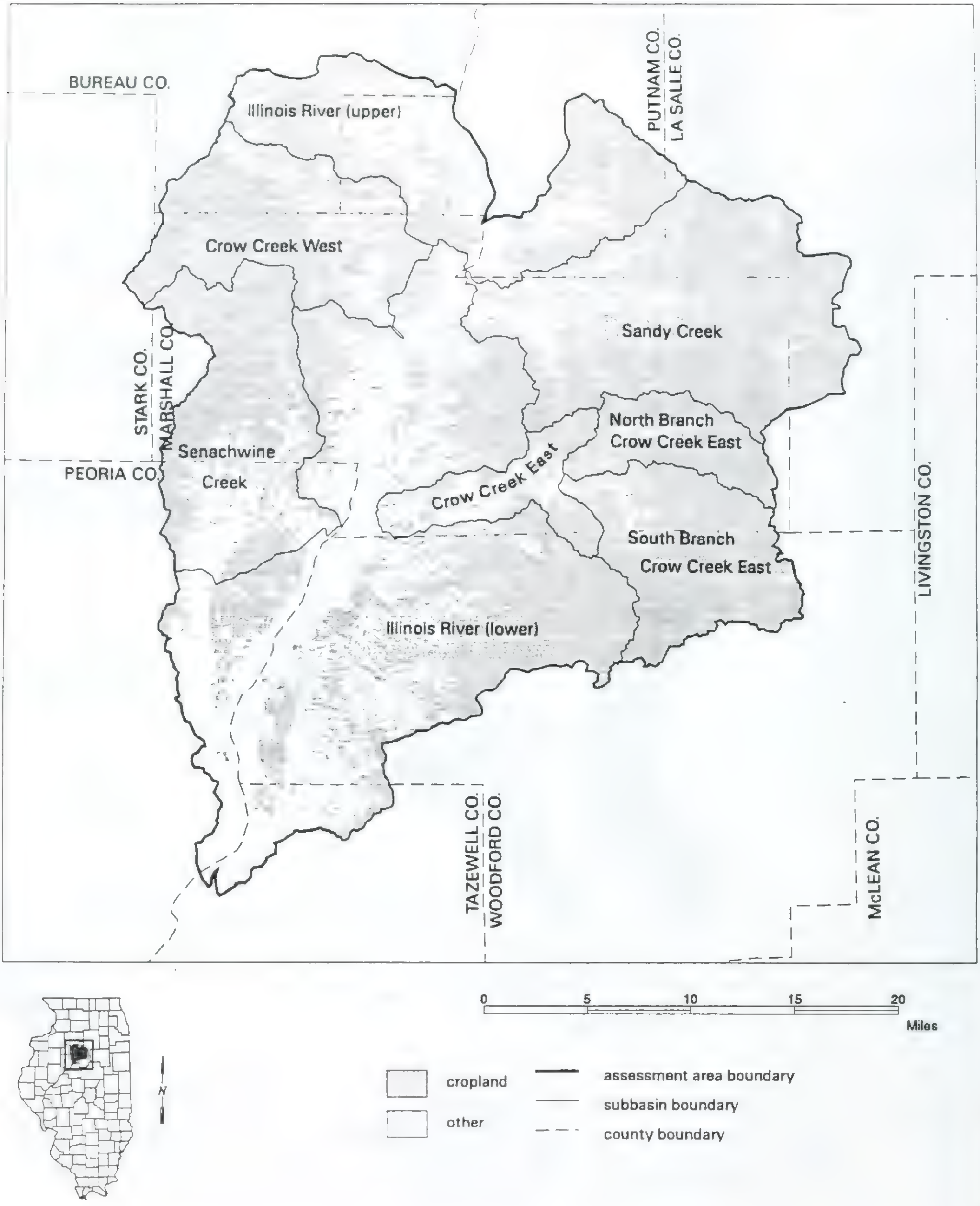

Figure 12. Principal Land Cover of the Illinois River Bluffs Assessment Area: Croplands (IDNR 1996)

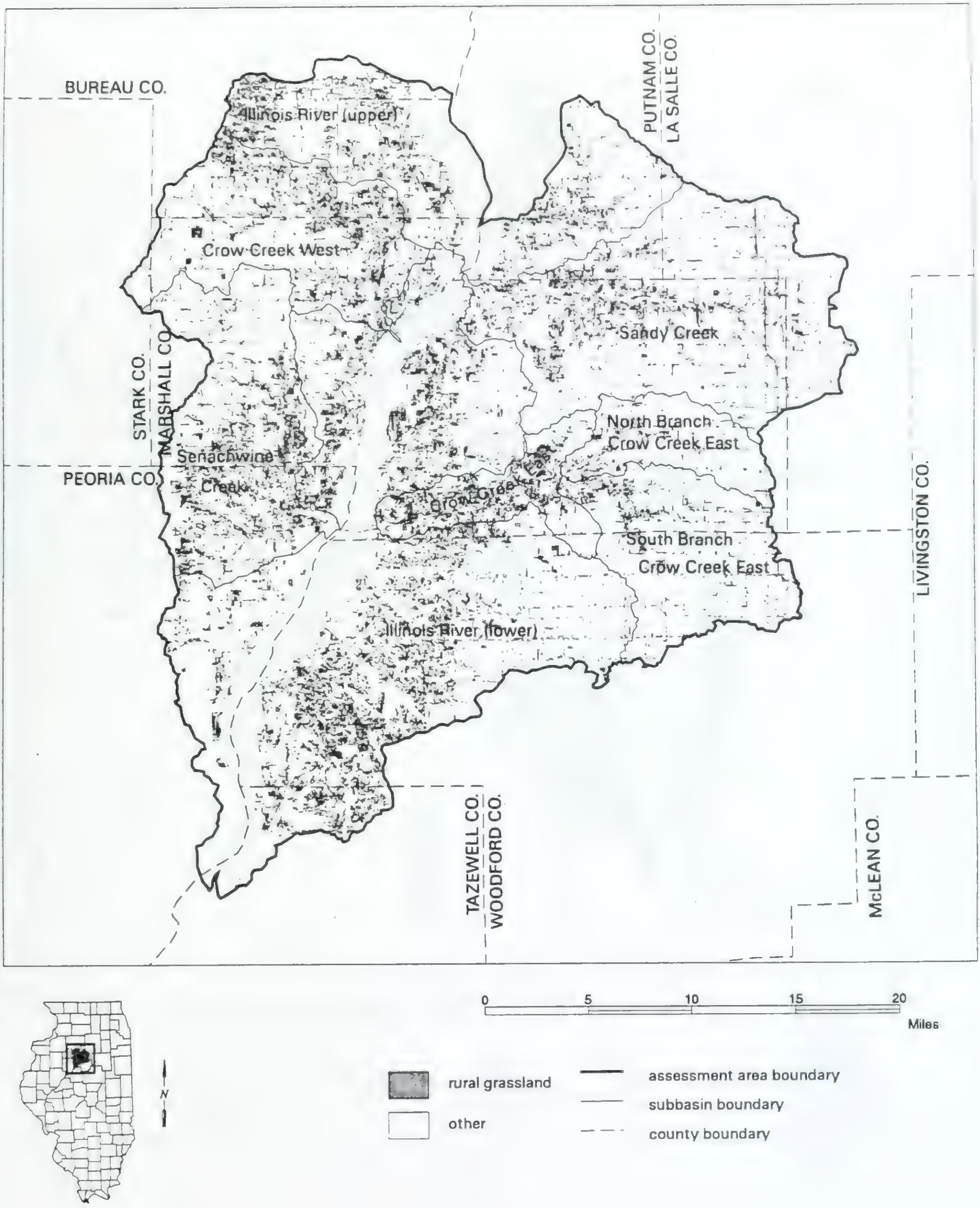

Figure 13. Principal Land Cover of the Illinois River Bluffs Assessment Area: Rural Grassland (IDNR 1996)

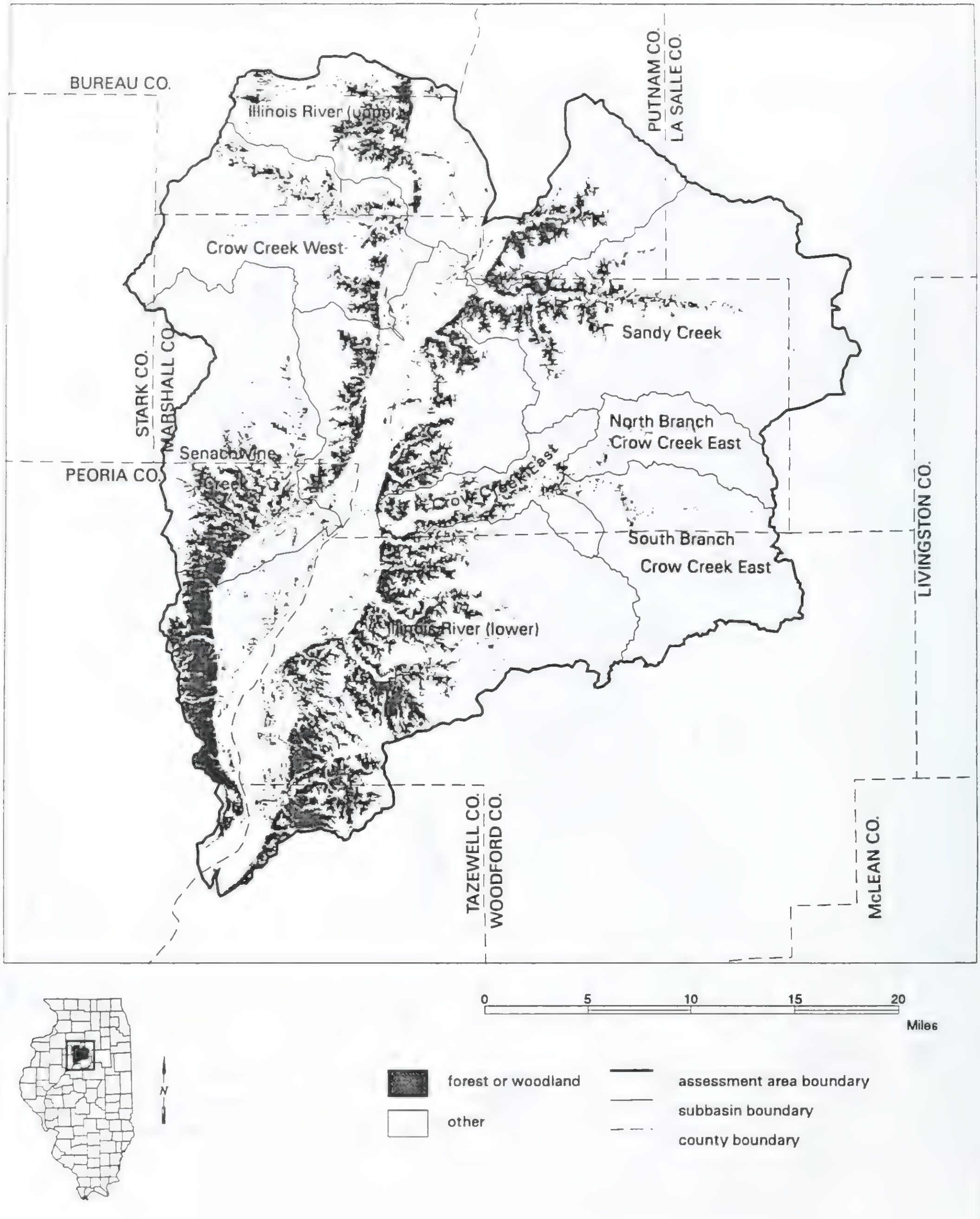

Figure 14. Principal Land Cover of the Illinois River Bluffs Assessment Area: Forest and Woodland (IDNR 1996)

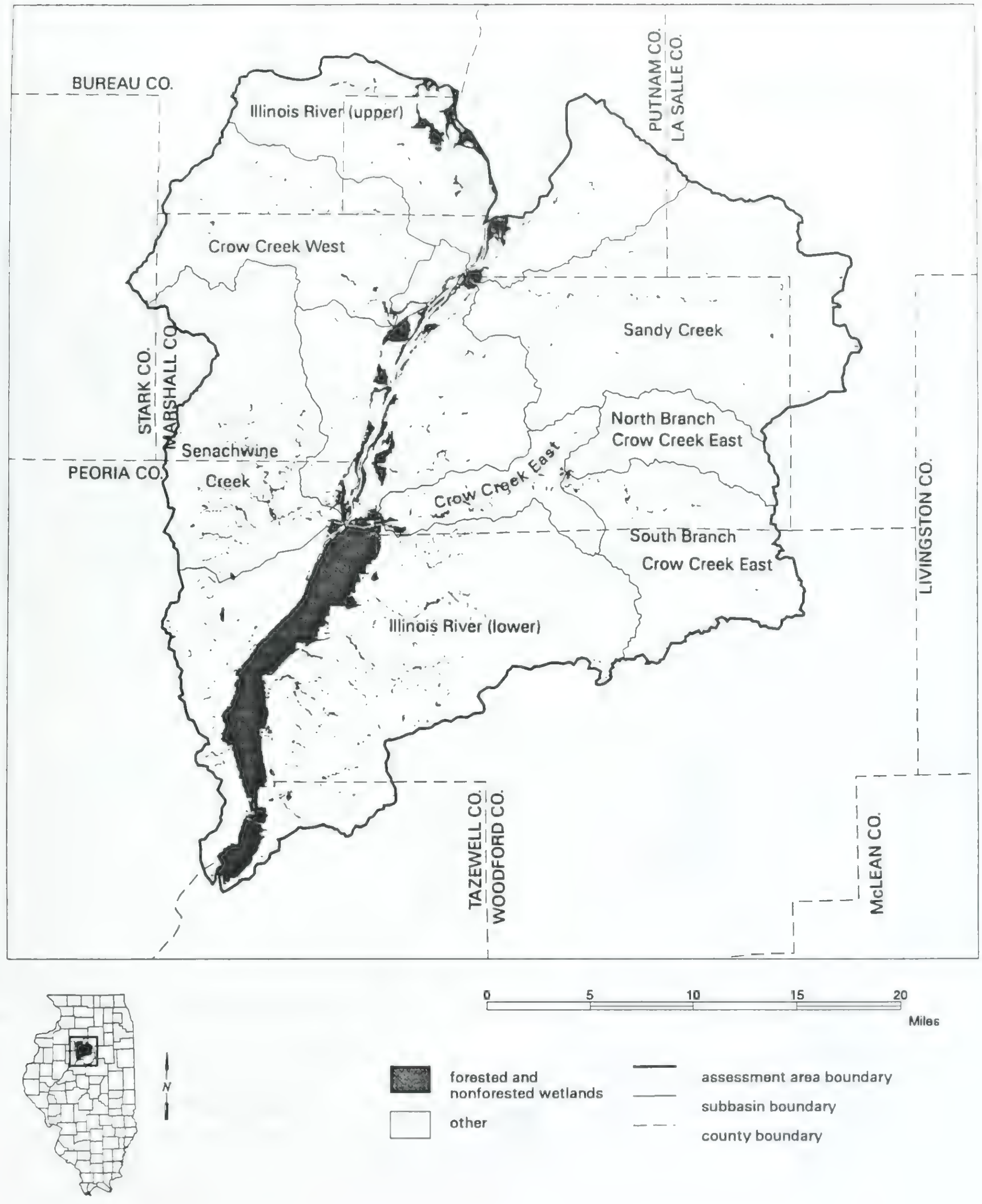

Figure 15. Principal Land Cover of the Illinois River Bluffs Assessment Area:
Forested and Nonforested Wetlands (IDNR 1996)

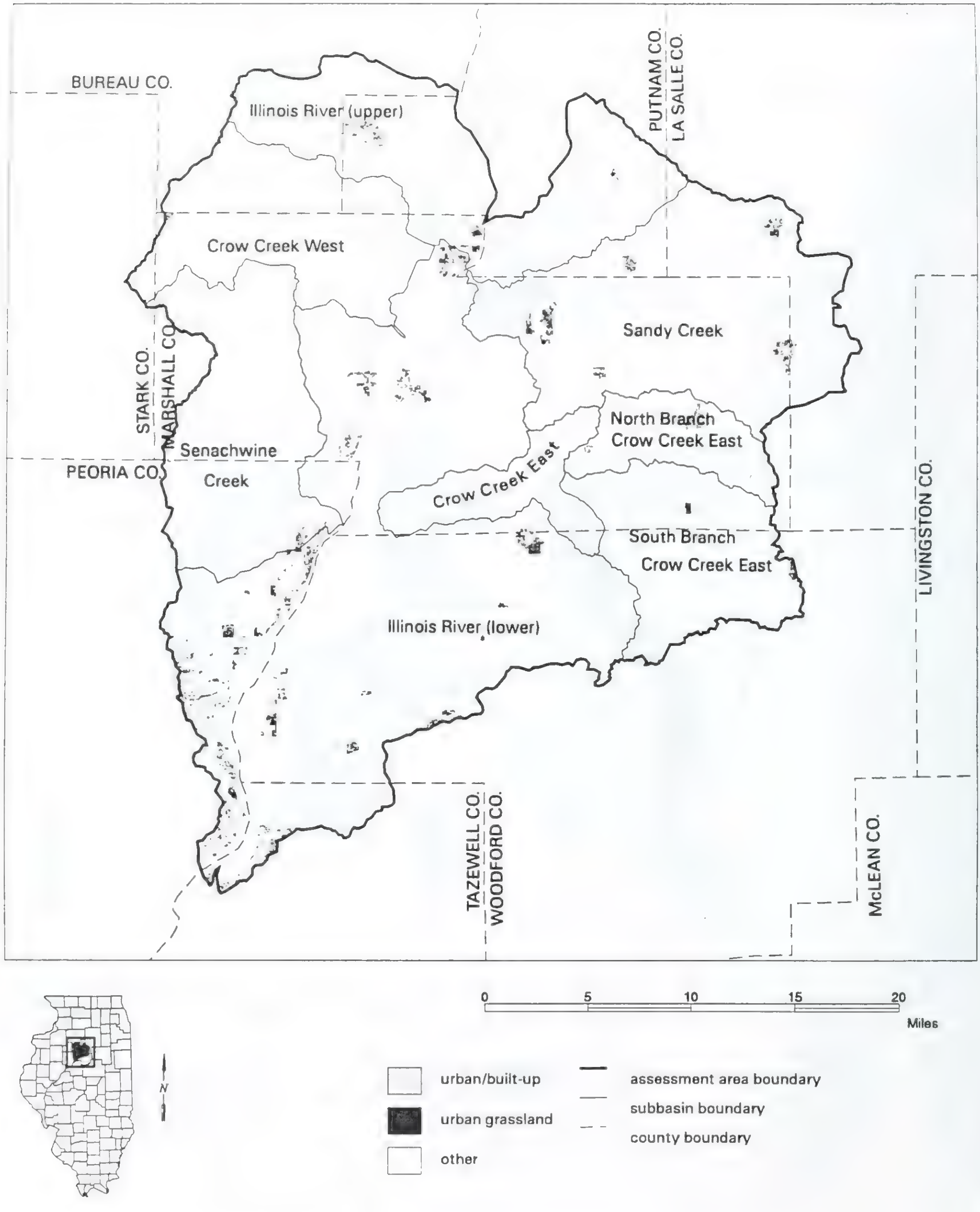

Figure 16. Principal Land Cover of the Illinois River Bluffs Assessment Area: Built-Up and Urban Grassland (IDNR 1996)

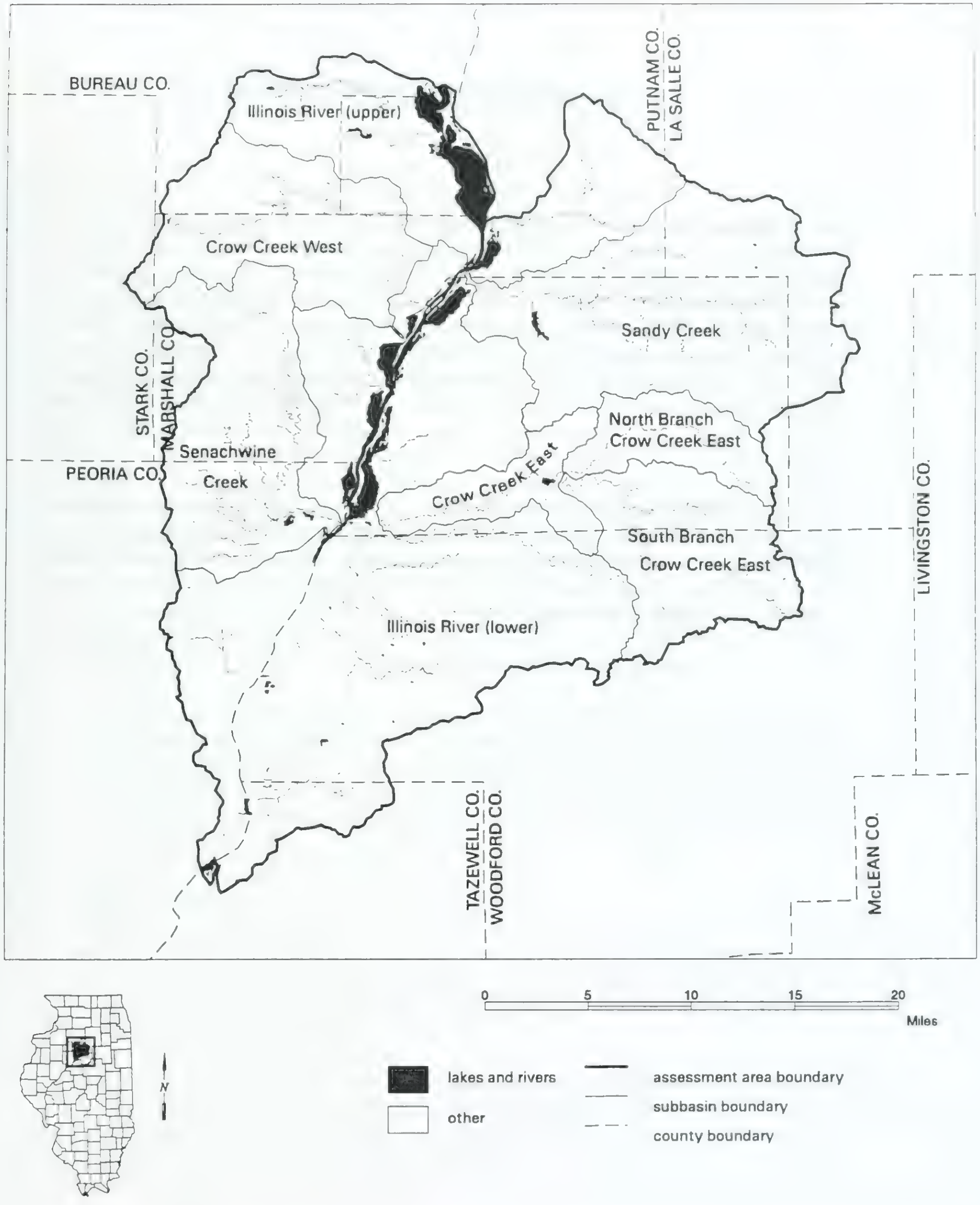

Figure 17. Principal Land Cover of the Illinois River Bluffs Assessment Area: Lakes and Rivers (IDNR 1996)

Part 2: Geology and Society

Most of us live, work, and play on the surface of the earth. But what we often fail to recognize is that beneath the office building or factory where we work, beneath the home where we live, or beneath the park where we play, is a framework of geology that supports our lives on the surface. The geologic framework contains the mineral resources that are the raw ingredients of most of the manufactured materials that furnish our homes, offices, and playgrounds; and it provides the water that flows freely from the faucets we turn on and off daily. At the same time, the contamination of water resources, the slumping of banks along our roads, or damage from earthquakes are hazards that we don't think about until they happen—let alone realize that a supporting framework of geology affects why they occur.

The interrelatedness between geology and human society is so intimate and intricate that it is easier ignored than understood. Nevertheless, to understand and wisely use the natural heritage we value, we must consider the geological factors that are part of our daily lives. Some of the major ways geologic materials, geologic resources, and geologic processes affect modern society are discussed below.

Mineral Resources

The major active mineral industry operations in the Illinois River Bluffs Assessment Area are the ten sand and gravel pits along the Illinois River (Figure 18). Data on production and employment for in the individual pits are not available. Sand and gravel is a commodity with a low unit value of about $4 per ton. As a consequence, the operations tend be close to the major areas of demand. Table 4 lists the sand and gravel operations in the assessment area. A few gas wells occur in the parts of Marshall, Peoria, and Woodford Counties falling within the assessment area. Data on production and employment for these wells are not available.

There is good potential for of mining sand and gravel in the assessment area (Figure 19). In addition to the resources shown in Figure 19, there are also deposits of sand and gravel that could be dredged from the Illinois River and adjoining lakes. Sand and gravel deposits in this assessment area occur in the Henry Formation (Figure 5). Deposits of windblown Parkland Sand occur in parts of Woodford County falling in this watershed (Lineback 1979).

The potential for commercial mining of limestone in this watershed is limited because most deposits in the area are Pennsylvanian sandstone or shale, which have little commercial value. At present no quarries are active in this assessment area.

Although there are coal deposits throughout the region, no coal mines are currently active in the assessment area.The Colchester, Danville, and Herrin Coals are present below the eastern part of the assessment area, yet underground mining of only the Colchester Coal has been done. Most the deposits mined west of the Illinois River were in the Danville Coal. It seems unlikely that any coal will be mined in the assessment area in the near future.

References

Baxter, J.W., 1987, Possible underground mining of limestone and dolomite in Central Illinois, *in* R.E. Hughes and J. Bradbury, eds., Proceedings of the 23rd Forum on the Geology of Industrial Minerals, May 11–15, 1987: Illinois State Geological Survey, Illinois Mineral Note 102, p. 21–28.

Bhagwat, S.B., 1989, Model of construction aggregates demand and supply—A Chicago area case study, *in* R.E. Hughes and J. Bradbury, eds., Proceedings of the 23rd Forum on the Geology of Industrial Minerals, May 11–15, 1987: Illinois State Geological Survey, Illinois Mineral Note 102, p. 29–34.

Ehrlinger, H.P., and J.M. Masters, 1974, Commercial Feldspar Resources in Southeastern Kankakee County, Illinois: Illinois State Geological Survey, Illinois Mineral Note 56, 18 p.

Lineback J.A., 1979, Quaternary Deposits of Illinois: Illinois State Geological Survey map, 1:500,000 scale.

Masters, J.M., 1983, Geology of Sand and Gravel Aggregate Resources of Illinois: Illinois State Geological Survey, Illinois Mineral Note 88, 10 p.

Samson, I.E., and J.M. Masters, 1992, Directory of Illinois Mineral Producers 1992: Illinois State Geological Survey, Illinois Minerals 109, 129 p.

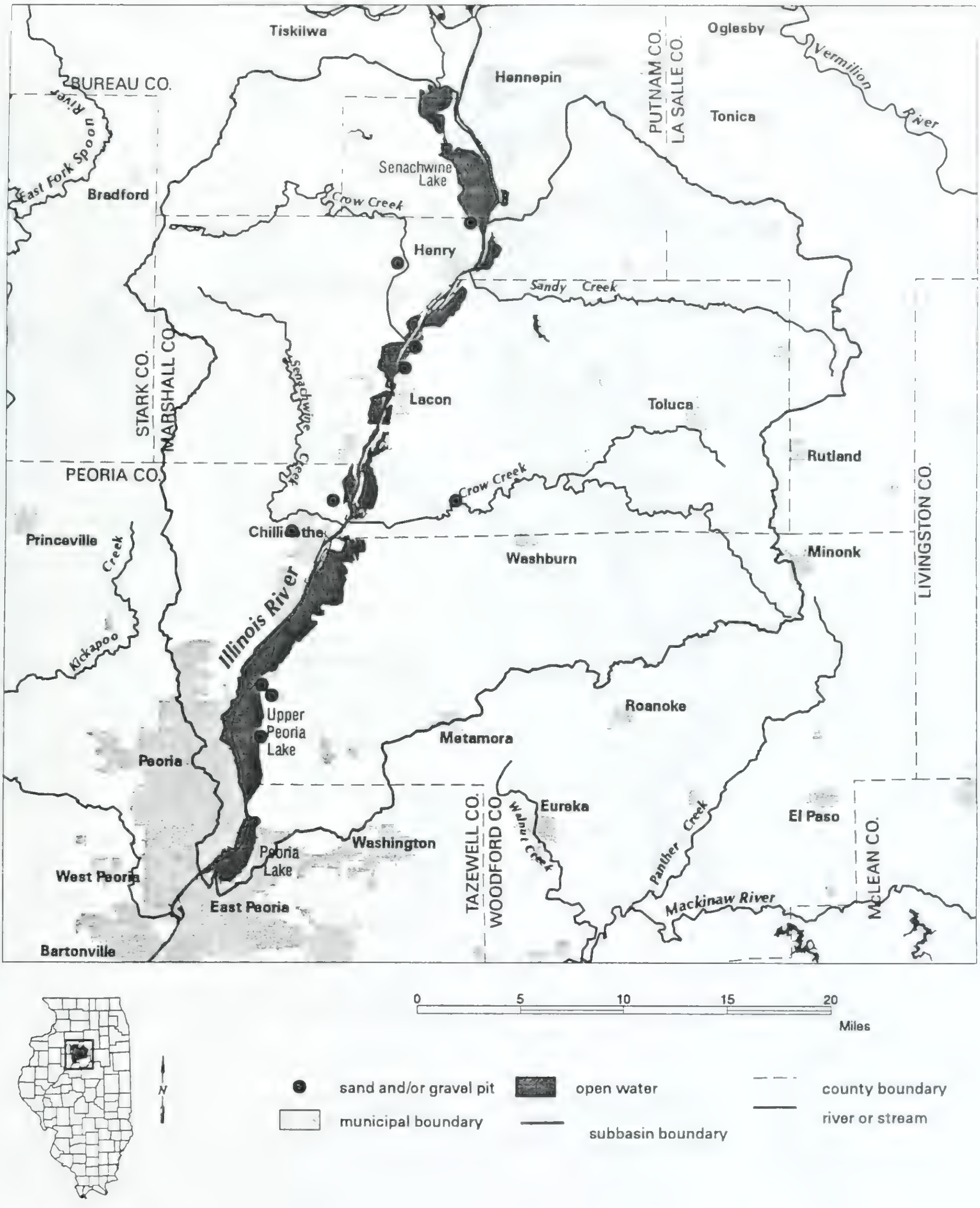

Figure 18. Active Sand and/or Gravel Pits in the Illinois River Bluffs Assessment Area

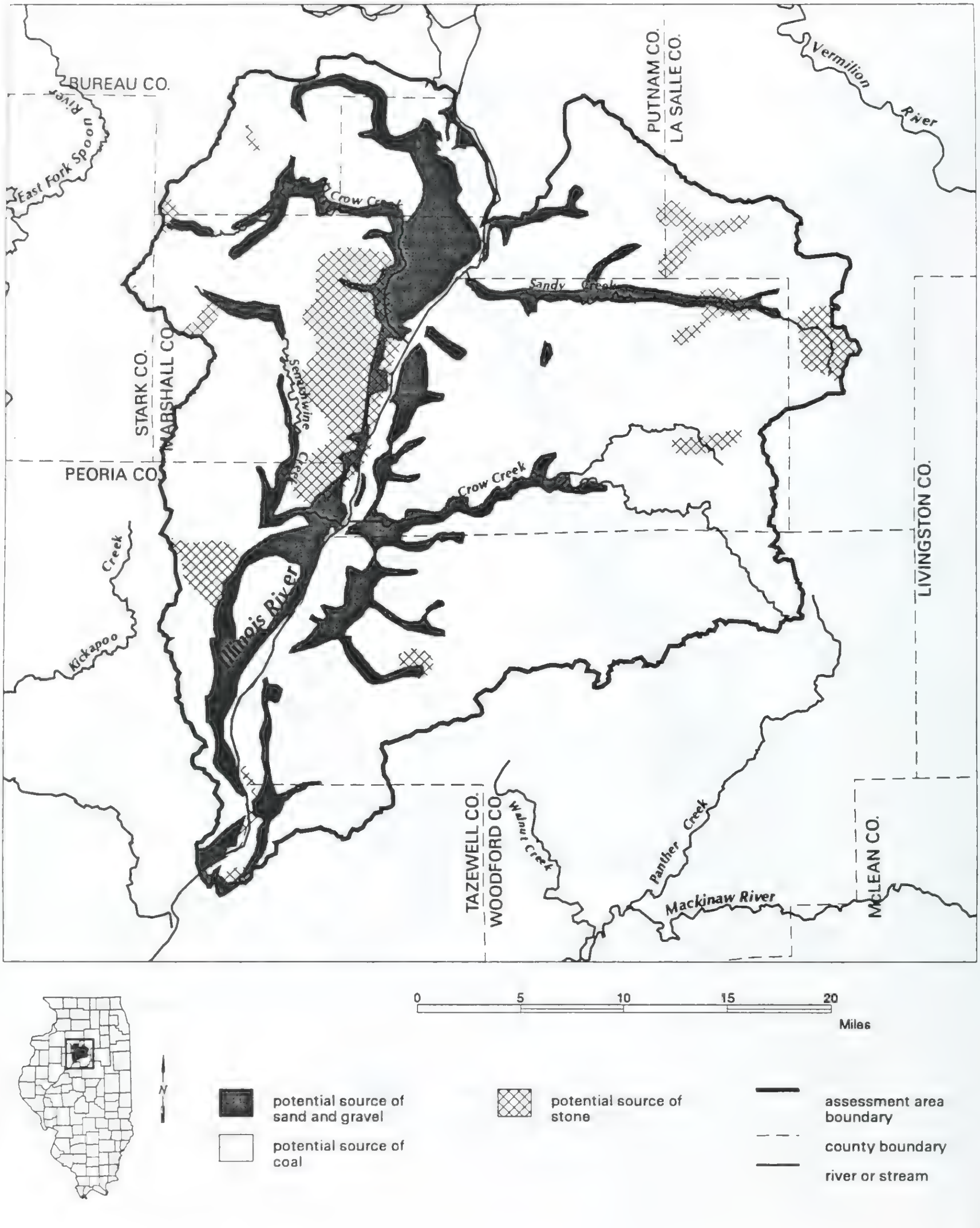

Figure 19. Potential Mineral Resources in the Illinois River Bluffs Assessment Area

Table 4. Mineral Industry Operations in Illinois River Watershed

Sand and Gravel

Henry Pit
Midwest Material Co.
P.O. Box 69, Lacon, IL 61540
County: Marshall
Mineral: Sand and Gravel

Sendelbach Pit
Walnut Sand and Gravel Co.
P.O. Box 708, Walnut, IL 61376
County: Marshall
Mineral: Sand and Gravel

Poignant Gravel Pit
P.O. Box 129, Lacon, IL 61540
County: Marshall
Mineral: Sand and Gravel

Lacon Pit
Midwest Material Co.
P.O. Box 69, Lacon, IL 61540
County: Marshall
Mineral: Sand and Gravel

Riverside Materials Pit
R.A. Cullinan & Sons, Inc.
P.O. Box 166, Tremont, IL 61568
County: Peoria
Mineral: Sand and Gravel

Fitschen Pit
Amigoni Construction Co.
800 N. State Street, Roanoke, IL 61561
County: Marshall
Mineral: Sand and Gravel

Chillicothe Pit
Galena Road Gravel Inc.
5129 E. Truitt Avenue
Chillicothe, IL 61523
County: Peoria
Mineral: Sand and Gravel

Construction Materials Co.
Rt. 26, 100 Cass Street
Peoria, IL 61602
County: Woodford
Mineral: Sand and Gravel

Powley Pit
Powley Sand and Gravel Co.
1509 Springbay Road
East Peoria, IL 61611
County: Woodford
Mineral: Sand and Gravel

Spring Bay Pit
Peoria Concrete Const.
P.O. Box 20, Roanke, IL 61561
County: Woodford
Mineral: Sand and Gravel

Aquifer Delineation

An aquifer can be defined as a body of water-saturated earth materials capable of yielding sufficient groundwater to a spring, small-diameter well, or a large-diameter, bored well for the intended use of the well. An aquifer will also yield water to any stream intercepting it. Aquifers in Illinois are composed of saturated sand and gravel, fractured or jointed limestone and dolomite, or permeable sandstone. Fine-grained earth materials such as silt, clay, shale, or till, which are described elsewhere in this report, may restrict the flow of groundwater through and between aquifers.

Aquifer thicknesses and distributions trend to be most variable in glacial deposits. Within aquifers, yield variability is greatest in limestone and dolomite aquifers found in the bedrock. The rock units making up the bedrock tend to be relatively uniform in character in the horizontal plane and show their greatest variability in character in the vertical direction. Sand and gravel aquifers in the glacial drift generally formed where glacial meltwater flowed out over the landscape and in stream channels during and following successive incursions and retreats of the glacial ice in the Illinois River Bluffs Assessment Area. Although sand and gravel may be the dominant lithology in the glacial sediments, the bulk of the glacial drift consists of diamicton, silt, and clay, all of which are fine-grained materials that restrict the flow of groundwater. Glacial aquifers are broadly categorized as basal, interbedded, or surficial.

Bedrock Aquifers

There is a limited availability of usable groundwater from the deeper bedrock formations in the Illinois River Bluffs Assessment Area. This limitation is caused by the presence of the Pennsylvanian shale at the bedrock surface, which adversely affects water quality. In fact, the limiting factor in groundwater in the deep bedrock formations (Cambrian through Devonian age) is groundwater *quality*, not *quantity*. Amount of mineralization is controlled mainly by groundwater age and depth of the aquifer.

Groundwater moving through rocks slowly absorbs rock minerals, and in general, older and deeper water is likely to be more mineralized. Aquifers in Illinois are replenished (recharged) with downward flowing water from precipitation; the rate of aquifer recharge depends on the permeability of the glacial deposits and the shallow bedrock. Given the right type of permeable glacial deposits, less mineralized water moving downward into these permeable deposits can "flushed out" more highly mineralized water. In the assessment area, the slowly permeable Pennsylvanian shale at the bedrock surface restricts recharge of the aquifers and thus increases mineralization of the groundwater in the underlying formations. As the Pennsylvanian shales thin significantly to the north, more rapid recharge of bedrock formations has reduced the level of mineralization in the aquifers.

Generally, the quality of groundwater from the deep bedrock formations renders the water unusable throughout most of the Illinois River Bluffs Assessment Area. Groundwater in all bedrock formations contains more than 500 mg/L of total dissolved solids (TDS) throughout the area, and many have much greater concentrations of TDS.

Groundwater from the Ironton-Galesville Sandstones has a TDS of 1,000 to 2,000 mg/L in the extreme northern part of Stark County, southeastern Henry County, and southwestern Bureau County. Mineralization rapidly rises to more than 10,000 mg/L a few miles to the south, making water there only marginally usable even in the extreme northern part of the assessment area.

Water in the St. Peter Sandstone of the Ancell Group ranges from more than 1,000 to more than 2,500 mg/L TDS. It is marginally usable throughout most of the assessment area, but mineralization tends to increase toward the southeast. In Marshall County, the towns of Toluca and Wenona both draw water from the St. Peter Sandstone. Their wells are 2,000 and 1,855 feet deep, respectively, and have highly mineralized water (2,322 ppm at Toluca and 1,437 ppm at Wenona). Minonk, although just east of the assessment area in Northwest Woodford County, also has wells that develop water supplies from the St. Peter, with a TDS of over 1,700 ppm. Just north of the assessment boundary, the towns of Granville and Standard both obtain water from the St. Peter, but the mineralization there is less than 1,000 ppm.

In most of Stark County, groundwater in the Galena-Platteville Groups has a TDS between 1,000 and 1,500 mg/L and may be marginally usable as an aquifer in this vicinity. Elsewhere in the assessment area, the TDS of the groundwater generally ranges from more than 2,000 to about 3,000 mg/L. The public well at Hopewell Estates develops part of its supply from the Galena-Platteville. In most of the assessment area, because of a limited degree of fracturing and crevicing, the Galena-Platteville acts as an aquitard, but locally it may have water-yielding fractures within it. The quality of the water ranges from marginal to unsuitable.

The low-permeability shale and dolomite of the uppermost Ordovician unit, the Maquoketa Group, offers no potential for a well.

The Silurian and Devonian formations overlying the Ordovician are at or near the bedrock surface only at the extreme northeast corner of the assessment area, in parts of Henry and Bureau Counties. There, and in Putnam County and western Stark County, quantities of usable water sufficient for domestic use may be obtained from these formations.

The lower Mississippian rocks (Kinderhook) are predominantly shale and do not yield water, but the overlying Burlington-Keokuk Limestones may provide enough water for a limited domestic supply, generally in the range of 1 to more than 5 gpm (gallons per minute). However, the water from these rocks is generally highly mineralized and not considered suitable for consumption.

The Pennsylvanian formations are composed predominantly of shale, which normally yields little or no water to a well. Discontinuous sandstones within the Pennsylvanian strata may yield small supplies suitable for domestic use, and some very small public supplies have been obtained from these materials. Pennsylvanian sandstones may yield enough groundwater to supply a farm, particularly in Putman and Marshall Counties. In general, however, the surficial Pennsylvanian bedrock only yields enough water for a domestic supply (less than 5 gpm).

Glacial Aquifers

Glacial (sand and gravel) aquifers are commonly used as water sources in the assessment area because of the high degree of mineralization of water obtained from the bedrock and the abundance of groundwater available from the major glacial aquifer in the present Illinois River valley. Glacial aquifers in the uplands can be roughly separated into **basal aquifers** (those resting on or near the bedrock), **interbedded aquifers** (those wholly contained within the glacial deposits), and **surficial aquifers** (generally the most recently deposited aquifers, with little or no surface cover). Surficial aquifers are the most vulnerable to contamination. Within the Illinois River valley, ancient terrace, recent surficial, and basal sand deposits form a virtually continuous sequence of aquifers from the land surface to the bedrock surface.

Sankoty Aquifer

Many towns in the Illinois River Bluffs Assessment Area obtain a water supply from the highly productive basal glacial drift aquifer found in the Sankoty Sand, which was deposited in the Ancient Mississippi River drainage, which is now occupied in part by the present Illinois River valley. This aquifer represents pre-Illinoian outwash sand and gravel deposited by water from melting glaciers that flowed down the Ancient Mississippi River drainage. The great thickness and lateral continuity of these deposits create a major aquifer capable of yielding several thousand gpm to a large-capacity well. Within the present Illinois River valley, these deposits are overlain by later outwash (Henry Formation) and modern river deposits, which essentially form one thick, continuous aquifer from the surface to the bedrock. The Sankoty deposits within the Illinois River valley can therefore be considered to be surficial as well as basal deposits, which makes them susceptible to surface contamination. Beyond the limits of the present valley, tills of the Illinois and Wisconsin Episodes overlie the Sankoty, which makes it less vulnerable to contamination. In the uplands, the elevation of the water level within the aquifer is similar to the water level within the Illinois River valley. Locally, however, the upper part of the Sankoty may be dry beneath the uplands. The Sankoty aquifer is present in a wide area of central Marshall County, most of Putnam County, western Woodford County, and northeastern Peoria County. Henry, Lacon, Peoria North, Chillicothe, and other small communities obtain their groundwater from this aquifer and the outwash deposits overlying it.

Other Glacial Aquifers

Beyond the limits of the Ancient Mississippi River Valley, in the eastern parts of Putnam and Marshall Counties and in western Woodford County, the potential yield from drift aquifers is much less. Small supplies are commonly available from basal sands, from interbedded deposits within the Glasford (Illinois Episode), and from deposits commonly encountered at the boundary between the Wedron (Wisconsin Episode) and Glasford formations. In some areas, these deposits are absent or thin, and drillers must resort to the construction of large-diameter wells. Limited deposits of the Henry Formation in small valleys may locally reach sufficient thickness for the deposit to provide a small to moderate yield of groundwater.

Summary

Water from the deepest sedimentary rocks of Cambrian age is generally too highly mineralized for consumption. Moderate sized, but mineralized water supplies may be obtained from the St. Peter Sandstone and Galena-Platteville dolomite. Small, and occasionally moderate, yields may be available from the upper bedrock formations of Silurian and Devonian age where they are not too deeply buried under Pennsylvanian shale. Small, very limited water supplies may be obtained in some places from thin sandstones within the Pennsylvanian shale.

Sand and gravel deposited in the Ancient Mississippi Valley (the Sankoty Aquifer) is a thick, widespread, productive aquifer in the Illinois River Bluffs Assessment Area. In the present valley of the Illinois River, where it is overlain by later glacial outwash deposits, the aquifer is capable of reliably producing very large water supplies. Beyond the boundaries of the Illinois River valley, where this aquifer is present, but overlain by the glacial diamicton covering the uplands, yields are less, but large supplies may still be reliably obtained. The aquifer is less vulnerable to contamination in the areas where it is covered by diamicton.

Discontinuous aquifers potentially capable of yielding small to possibly moderate water supplies may be present locally in tributary stream valleys. The remainder of the unconsolidated (glacial) deposits generally offer only discontinuous aquifers capable of yielding only small supplies to drilled wells. In some areas, large-diameter wells are necessary to obtain an adequate supply.

References

Anderson, R.C., and R.E. Hunter, 1965, Sand and Gravel Resources of Peoria County: Illinois State Geological Survey Circular 381, 16 p.

Bergstrom, R.E., 1956, Groundwater Possibilities in Western Illinois, North Part—A Preliminary Geologic Report: Illinois State Geological Survey Circular 222, 28 p.

Brower, R.D., A.P. Visocky, I.G. Krapac, B.R. Hensel, G.R. Peyton, J.S. Nealon, and M. Guthrie, 1989, Evaluation of Underground Injection of Industrial Waste in Illinois: Illinois Scientific Surveys Joint Report 2, 8 chapters, 1 appendix.

Cady, G.H., 1919, Geology and Mineral Resources of the Hennepin and La Salle Quadrangles: Illinois State Geological Survey Bulletin 37, 136 p.

Hackett, J.E., and R.E. Bergstrom, 1956, Groundwater in Northwestern Illinois: Illinois State Geological Survey Circular 207, 25 p.

Hansel, A.K., and W.H. Johnson, 1996, Wedron and Mason Groups—Lithostratigraphic Reclassification of Deposits of the Wisconsin Episode, Lake Michigan Lobe Area: Illinois State Geological Survey Bulletin 104, 116 p.; plate 1: Quaternary Deposits of Illinois (map).

Herzog, B., and others, 1994, Buried Bedrock Surface of Illinois: Illinois State Geological Survey and U.S. Geological Survey, Illinois Map 5.

Horberg, L., 1950, Bedrock Topography of Illinois: Illinois State Geological Survey Bulletin 73, 111 p.

Horberg, L., M. Suter, and T.E. Larson, 1950, Groundwater in the Peoria Region: Illinois State Geological Survey Bulletin 75, 128 p.

McComas, M.R., 1969, Pleistocene Geology and Hydrogeology of the Middle Illinois Valley, Ph.D. Thesis, University of Illinois, 130 p.

Nealon, J.S., J. Kirk, and A.P Visocky, 1989, Regional Assessment of Northern Illinois Groundwater Resources: Illinois State Water Survey Contract Report 473, 83 p.

Nelson, W.J., 1995, Structural Features of Illinois: Illinois State Geological Survey Bulletin 100, 144 p.

Piskin, K., and R.E. Bergstrom, 1975, Glacial Drift in Illinois—Thickness and Character: Illinois State Geological Survey Circular 490, 35 p.

Public-Industrial-Commercial Supplies Database (PICS), 1996: Illinois State Water Survey.

Selkregg, L.F., and J.P. Kempton, 1958, Groundwater Geology in East-Central Illinois—A Preliminary Geologic Report: Illinois State Geological Survey Circular 248, 36 p.

Smith, W.H., and D.J. Berggren, 1963, Strippable Coal Reserves of Illinois: Illinois State Geological Survey Circular 348, 59 p.

Treworgy, J.D., 1981, Structural Features in Illinois—A Compendium: Illinois State Geological Survey Circular 519, 22 p.

Visocky, A.P., M.G. Sherrill, and K. Cartwright, 1985, Geology, Hydrology, and Water Quality of the Cambrian and Ordovician Systems in Northern Illinois: Illinois State Geological and Water Surveys Cooperative Groundwater/Resources Report 10, 136 p.

Wehrmann, H.A., A.P. Visocky, B.Burris, R. Ringler, and R.D. Brower, 1980, Assessment of Eighteen Public Groundwater Supplies in Illinois: Illinois State Water Survey Contract Report 237, 185 p.

Willman, H.B., 1973, Geology Along the Illinois Waterway—A Basis for Environmental Planning: Illinois State Geological Survey Circular 478, 48 p.

Willman, H.B., 1973, Rock Stratigraphy of the Silurian System in Northeastern and Northwestern Illinois: Illinois State Geological Survey Circular 479, 55 p.

Willman, H.B., J.C. Frye, J.A. Simon, K.E. Clegg, K.H. Swann, E. Atherton, C. Collinson, J.A. Lineback, and T.C. Buschbach, 1967, Geologic Map of Illinois: Illinois State Geological Survey.

Willman, H.B., J.C. Frye, 1970, Pleistocene Stratigraphy of Illinois: Illinois State Geological Survey Bulletin 94, 204 p.

Woller, D.M., and E.W. Sanderson, 1976, Public Groundwater Supplies in Putman County: Illinois State Water Survey Bulletin 60-18, 13 p.

Woller, D.M., M.L. Sargent, R.D. Olson, and E.W. Sanderson, 1990, Public Groundwater Supplies in Marshall County, Illinois: Illinois State Water Survey Bulletin 60-36, 37 p.

Potential for Geologic Hazards

Determining appropriate land use in the Illinois River Bluffs Assessment Area requires an understanding of the potential natural and society-induced geologic hazards inherent to the area. Geologic hazards develop through interactions between geologic materials and natural forces and can be influenced by human activities. This section will sensitize readers to some of the potential geologic hazards, including groundwater contamination, that can occur in the Illinois River Bluffs area. Site-specific geologic conditions or hazards are not comprehensively discussed. For a broader view of geologic hazards and what measures to take when they occur, consult *The Citizen's Guide to Geologic Hazards*. Prepared by the American Institute of Professional Geologists, this publication covers both hazards that arise from naturally occurring geologic materials (such as radon and asbestos) and from geologic processes (such as earthquakes, landslides, and flooding). In addition, its appendices list sources of help from professional geologists and insurance professionals. The publication may be ordered by contacting:

American Institute of Professional Geologists
7828 Vance Drive
Suite 103
Arvada, CO 80003
Telephone: (303) 431-0831

Potential for Contamination of Groundwater Resources

Groundwater contamination can arise from many sources. These sources are generally grouped into two classes, point or nonpoint, based on the size of the area where a chemical is applied or spilled, or a waste material is deposited. Point sources of contamination include many types of facilities and activities, such as landfills, chemical storage tanks (both above and below ground surface), individual septic systems, homeowner disposal of unwanted chemicals (for example, paint or used motor oil), the over-application of lawn fertilizers and pesticides at individual residences, and the facilities of pesticide and fertilizer dealers or applicators, etc.

The primary nonpoint source of potential contamination in Illinois is the agricultural use of pesticides and fertilizers. Urban and suburban sources of groundwater contamination, such as septic systems and overuse of lawn fertilizers and pesticides, can also become nonpoint problems if a significant concentration of these sources occurs in a subdivision or other area.

Groundwater contamination can be defined as the presence of a chemical at or below the water table in concentrations that exceed federal or state acceptable levels. Flowing

groundwater is the means of transporting these dissolved contaminants away from their source. Responsible chemical use and prompt cleanup of spills can prevent the degradation or contamination of groundwater. In addition, it can be helpful to restrict or closely monitor activities that can contribute to groundwater contamination, particularly when they are conducted in or near the setback zone of a water supply well. The Illinois EPA provides information on the delineation of setback zones and the evaluation of activities within these areas (Cobb and others 1995).

The potential for groundwater contamination depends on a complicated combination of hydrogeologic properties, environmental processes, and the quantity and nature of the contaminant in question. In general, as depth to the top of the uppermost aquifer increases, the sensitivity to contamination of that particular aquifer decreases. Greater depth from the ground surface affords an aquifer greater protection, due to the increased opportunity for adsorption, microbial degradation, and dilution of a spilled contaminant before it can reach the aquifer. The validity of this statement, however, depends on several other factors. The effects of these various factors on contaminant fate and transport are discussed below.

Effects of Climatic Variables on the Fate of the Contaminant

Four climatic variables (precipitation, temperature, humidity, and wind speed) help determine the fate of subsurface chemicals through their impact on several processes. The amount and intensity of rain helps to determine the amount of runoff from the soil surface and, consequently, the amount of water infiltrating the soil surface. Temperature, humidity, and wind speed influence water and chemical movement through their effects on the processes of evaporation, transpiration, volatilization, and condensation.

Evaporation of water from the soil and transpiration of water from plants both reduce the amount of water in the soil that percolates downward to the water table. Depending on the depth of the water table and the depth and distribution of plant roots, plants can even remove water from below the water table.

Volatilization is the process whereby a chemical in a liquid state is heated enough to convert it to a gaseous state. Gasoline is one example of a chemical that can volatilize at temperatures normally found in the soil during Illinois summers. Condensation is the process whereby gaseous chemicals are cooled into a liquid state. Once condensed, the chemical may become dissolved in water and leach to the groundwater system. Thus, chemicals that have been volatilized and remain trapped as gases in soil can condense back to a liquid form and leach to groundwater.

Effects of Quantity and Chemical Characteristics on the Fate of the Contaminant

The quantity and nature of a chemical spill or application, as well as the chemical properties of the contaminant, also help determine whether groundwater contamination will occur and the amount of groundwater that will become contaminated. The larger the quantity of contaminant that is released, the more likely it is that some fraction of the chemical will leach to groundwater. In addition, the depth from the land surface to the aquifer and the

area of land exposed to the chemical will also affect the likelihood of groundwater contamination. For example, a herbicide applied to the land surface at a rate of 3 pounds per acre, over 640 acres will have a much lower likelihood of causing significant groundwater contamination than a leaking gasoline storage tank that is 15 feet below land surface.

Several chemical properties affect the fate of a chemical in the subsurface. These properties include, but are not limited to, water solubility (the amount of a chemical that can dissolve in water) and the adsorption coefficient (a measure of the tendency for a chemical to stick to the outside of soil particles). Many chemicals applied to agricultural fields are removed by runoff and soil erosion during rainfalls. The water solubility of a chemical helps control how readily the chemical mixes, or dissolves, in water. Less-soluble compounds will generally not move as rapidly as more-soluble compounds. Adsorption is the process whereby a molecule of a chemical sticks to the surface of a soil particle. Like solubility, adsorption is important in helping to control the rate of chemical movement in the subsurface. Many organic chemicals found in pesticides or used in solvents are strongly adsorbed by the organic matter or clay minerals in soil, which slows their flow to groundwater resources. Nitrate, however, does not adsorb to soil particles, and so moves much more rapidly in groundwater than do pesticides.

In addition to solubility and adsorption characteristics, potential contaminants are also characterized by their half-life. The half-life of a chemical is a measure of the speed with which it can be degraded by microbial organisms or by exposure to other natural processes. In general, these processes break the chemical down into smaller compounds that may be less toxic or even nontoxic.

Effects of Geologic Materials

Whether groundwater becomes contaminated also depends heavily upon the hydrogeologic characteristics of the area. Groundwater flow is largely controlled by the hydraulic conductivity of the geologic materials and the hydraulic gradient of the system. Hydraulic conductivity is a measure of the ability of water to flow through a geologic deposit. For example, sand and gravel deposits generally have high hydraulic conductivity values, whereas clayey diamictons generally have low hydraulic conductivity values. Some geologic materials are fractured, and depending on the size and spacing of the fractures, hydraulic conductivities in these units can be much higher than unfractured materials.

Hydraulic gradient is the difference in groundwater pressure between two points. Under a large hydraulic gradient (or a large difference in pressure), water and dissolved contaminants will move more quickly through a given geologic material than under a small hydraulic gradient.

Because the measurement of hydraulic conductivity and hydraulic gradient requires significant commitments of time and money, other methods have been developed to estimate the potential for groundwater contamination.

Potential for Groundwater Contamination

Most discussions of groundwater contamination do not distinguish between groundwater contamination and aquifer contamination. This distinction can have very important practical consequences. Technically, any time a chemical leaches into the water table to a concentration above a level established by a state or federal agency, groundwater is contaminated. In most of Illinois, however, contamination of shallow groundwater would not necessarily result in contamination of the uppermost aquifer because the uppermost aquifer commonly lies deeper than 20 feet from the surface. Most water supplies that use groundwater rely on the water in aquifers for that supply. For this reason, most concerns regarding groundwater quality generally refer to the protection of the water quality in aquifers rather than all groundwater.

In regions without aquifers, private water supplies may have to draw water from nonaquifer materials with low hydraulic conductivities by using large-diameter dug or bored wells. Residents of these regions must be concerned with the contamination of *any* groundwater.

The contamination potential of shallow aquifers is estimated using information on the occurrence and depth of shallow sand and sand and gravel deposits, and on the leaching characteristics of mapped soils (Keefer 1995). It is important to recognize that, by definition, aquifers are geologic deposits that are saturated with water. Sand and gravel deposits may not be aquifers when they are saturated only partially or seasonally. The statewide prediction of contamination potential by Keefer (1995) recognized these factors, but noted that the relative contaminant transport properties of aquifer and nonaquifer materials did not change significantly when the materials were unsaturated. For this reason, all mapped deposits of aquifer material (i.e., sand, sand and gravel, fractured limestone or dolomite, and permeable sandstone) were treated as aquifers by Keefer (1995), and are treated similarly in this discussion.

To create the aquifer sensitivity map of the assessment area (Figure 20), the soils of the assessment area were first classified according to their predicted pesticide leaching characteristics (Keefer 1995). Soils with greater organic-matter contents were generally classified as having lower leaching potential (greater ability to retain contaminants and prevent aquifer contamination) than soils with smaller organic-matter contents. In addition, soils with smaller hydraulic conductivities or poor drainage characteristics were classified as having lower leaching potential than soils with larger hydraulic conductivities and better drainage

These aquifer sensitivity classifications are based only on the generalized characteristics of the mapped geologic materials. Water quality information was not used because no suitable information was available. This map (Figure 20) was designed to be used for statewide screening purposes. These limitations should be considered, however, before using the aquifer sensitivity interpretations for anything other than broad screening decisions at the watershed or subbasin level.

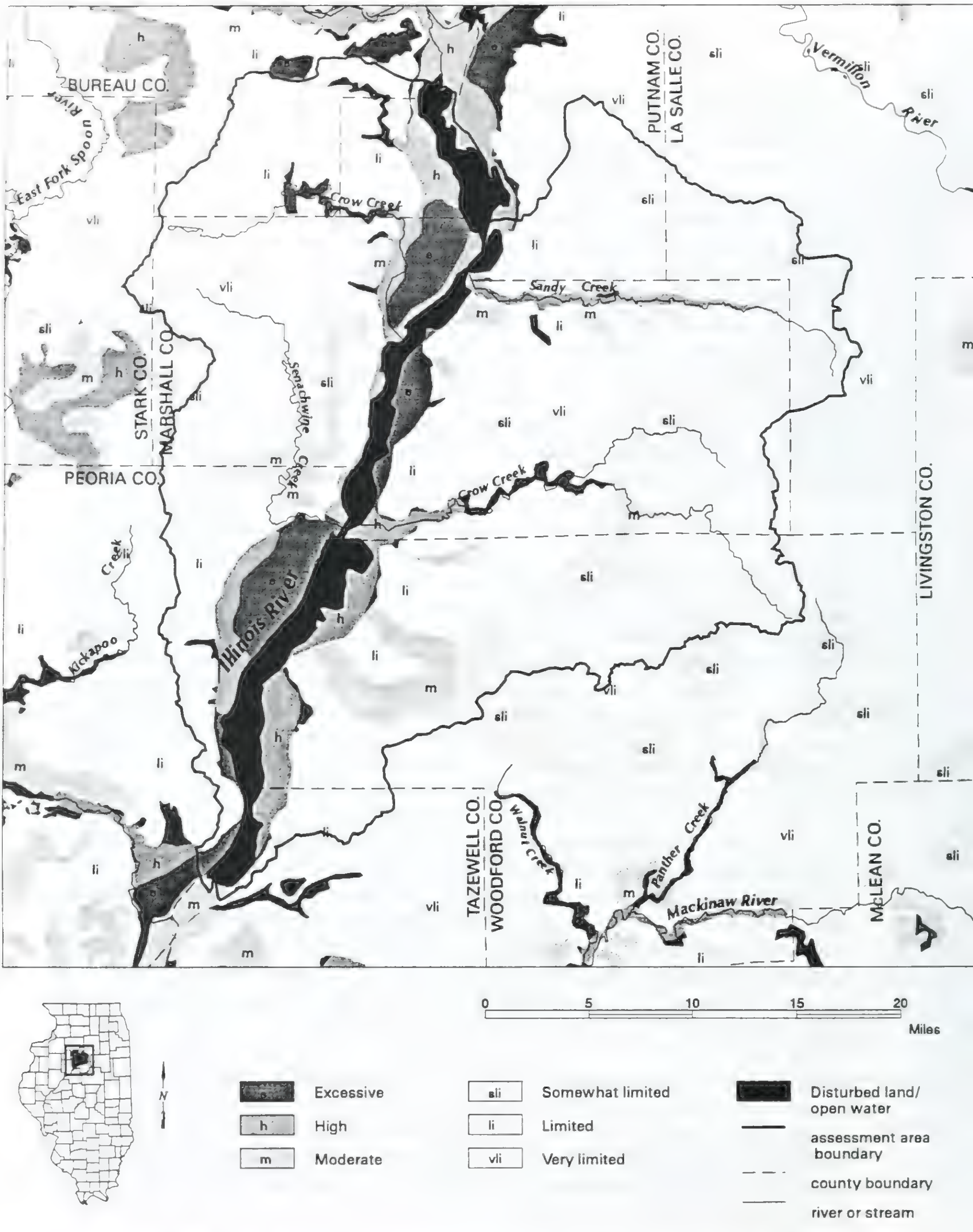

Figure 20. Aquifer Sensitivity to Contamination by Pesticide Leaching (Keefer 1995)

Potential for Groundwater Contamination in the Illinois River Bluffs Assessment Area

Sand and gravel deposits generally lie less than 20 feet below land surface in the lowlands along the Illinois River. Coarse grained aquifer materials occur between 20 and 50 feet below the land surface over approximately 20% of the upland areas (Berg and Kempton 1988). Because of local variations in topography, however, these aquifers may locally lie deeper than 50 feet. In most of the upland areas, no aquifer materials have been identified within 50 feet of land surface.

Because the surficial geologic materials in the upland areas of the Illinois River Bluffs Assessment Area are primarily fine grained, their pesticide leaching characteristics are determined primarily by slope and landscape position. The flat, upland areas in the eastern half of the area and limited portions of the northwestern part are dominated by soils with Very Limited pesticide leaching characteristics. The sloping uplands that occur throughout most of the remaining parts of the assessment area are dominated by soils with Moderate pesticide leaching characteristics. The flat lowland areas, where they are covered by fine-grained surficial deposits, have Very Limited pesticide leaching characteristics. Where sand deposits are at or near land surface, however, the soils have Moderate to Somewhat Limited pesticide leaching characteristics.

The relative sensitivity to contamination of the shallow aquifers in the Illinois River Bluffs Assessment Area is shown in Figure 20. This figure shows that the uplands in the assessment area have predominantly a Very Limited sensitivity to contamination because of the general lack of aquifers in the upper 50 feet of materials in these areas. Uplands that are underlain by aquifers lying between 20 and 50 feet below the surface are common in the Sandy Creek, North Branch Crow Creek East, and South Branch Crow Creek East subbasins, as well as in the Illinois River (lower) subbasin. In relatively flat areas, where aquifers lie 20 to 50 feet below the surface, the aquifer sensitivity is generally Somewhat Limited. Where these areas have more relief, the aquifer sensitivity is Moderate. In the lowland areas, where aquifers commonly lie at depths less than 20 feet, the aquifer sensitivity depends primarily on the soil pesticide leaching characteristics. Where the soils are classified as having a Moderate leaching characteristic, the aquifer sensitivity is characterized as Excessive. Where the leaching characteristics are Very Limited, the aquifer sensitivity is classified as High.

Several IDNR and ISGS publications address issues related to groundwater contamination potential. These include Keefer (1995), Herzog and others (1995), Risatti and Mehnert (1995), and Schock and others (1992).

Regional Earthquake History

PEKIN, ILL. October 31, 1895:

> At 5:20 in the morning there was a severe earthquake shock. First came a sudden quick shock like an explosion, accompanied by low rumblings that seemed to come from the sky. About a minute later there was a second shock, which lasted about a minute and a half. It awoke everybody, rattled windows and pictures. It rolled one man, who was sleeping in the third story of a building, out of bed, and in another part of town caused a bed to roll several inches. It caused much excitement, but did no damage.
>
> —The Dubuque, Iowa, *Telegraph Herald*

Earthquakes are more of an occasional curiosity then a dangerous hazard in the Illinois River Bluffs Assessment Area. Small earthquakes are known to occur on rare occasions in the area. Larger, more frequent earthquakes in the more seismically active regions of southern and southwestern Illinois also shake the area. The 1895 quake that so rudely awakened the residents of Pekin is a good example. It was located about 10 miles south of Cairo, Illinois, and probably measured about 6.2 on the Richter magnitude scale. Even the most powerful earthquakes from these southern regions, which are not expected to recur in the near future, would cause a stir in the Illinois River Bluffs area, but only minor damage.

Only three small earthquakes have been reported over the last century in counties adjacent to the assessment area. This number increases to nine if the surrounding area is considered (Figure 21). Most of these small earthquakes occurred before seismometers were installed in the region in the 1960s, so we can only estimate that their magnitudes were somewhere between 3.0 and 4.7. None of these small earthquakes are known to have caused any damage within the assessment area, and only the ones with estimated magnitudes of 4.0 or greater were even felt more than about 10 miles from their epicenters. The 1972 earthquake centered in Lee County, north of the assessment area, was recorded by modern seismometers and accurately measured at a magnitude of 4.5 on the Richter scale. It occurred a few minutes past midnight on the morning of September 15. It was felt throughout the assessment area, awakening a few sleepers, particularly in the northern half of the area. The 1909 earthquake, centered in Whiteside County and with an estimated magnitude of 4.7, was also felt throughout the entire region; it rattled windows and dishes. The 1909 earthquake in Mason County, had an estimated magnitude of 4.5, and was not reported in the assessment area, but it sent hundreds of frightened residents into the streets of Mason City. Earthquakes of this type could possibly reach magnitudes as great as 5.0. At that size, minor damage, such as broken chimneys and cracked or broken plaster walls, could be expected.

The Wabash Valley Seismic Zone, about 200 miles to the southeast of the assessment area, spawns magnitude 5 earthquakes about every 10 years. The magnitude 5.0 earthquake of 1987, and the magnitude 5.2 earthquake of 1968, were felt by people indoors, but generally were not felt by people who were outdoors at the time. However, most people in a small

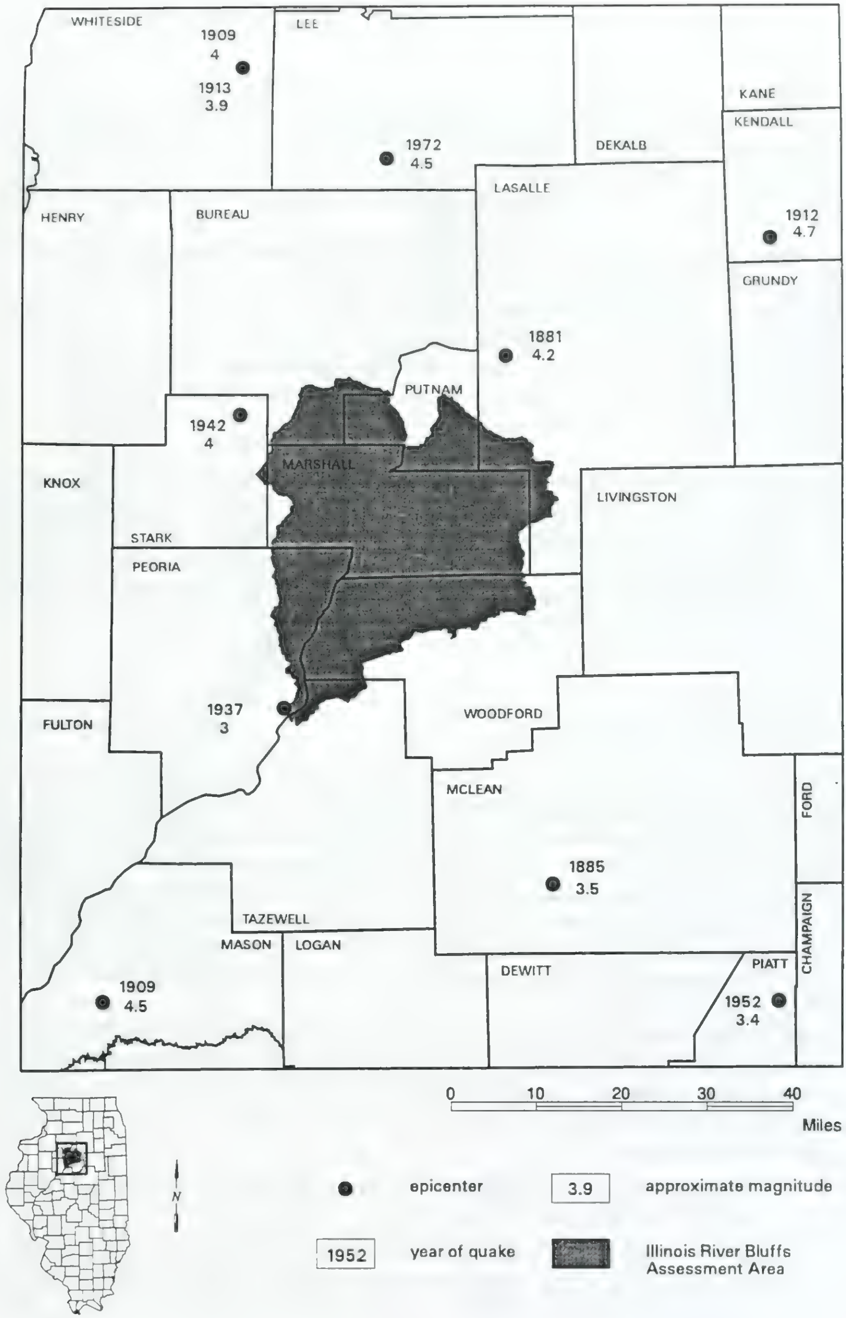

Figure 21. Earthquakes in the Vicinity of the Illinois River Bluffs Assessment Area (St. Louis University Earthquake Center database 1996)

area around Peoria reported feeling the 1987 earthquake, which rattled windows and dishes. The Wabash Valley Seismic Zone could produce earthquakes as large as Richter magnitude 6.5. Such a quake might cause damage to chimneys and older brick structures in the assessment area, but the likelihood of one occurring in the near future is very low.

The New Madrid Seismic Zone in far southern Illinois, Missouri, Kentucky, and Tennessee is capable of producing very powerful earthquakes; but because it is 270 to 350 miles to the south, the resulting ground motion in the assessment area is not expected to be dangerous. The magnitude 6.2 earthquake of 1895, which woke people in Pekin, occurred in the northern part of the New Madrid Zone and caused severe damage in southern Illinois towns. A similar earthquake, with similar effects, is expected to occur in the New Madrid Seismic Zone sometime in the next 15 years.

An even stronger series of earthquakes occurred in the New Madrid Seismic Zone in 1811–1812. Devastating earthquakes, probably as large as Richter magnitude 8, occurred three times that winter. There is no record of the ground motions in the assessment area from those earthquakes, but it is estimated that the motions would probably have been strong enough to damage masonry structures. Fortunately, such a large earthquake is not expected to recur within the next several hundred years.

Landslides

When most people think of landslides, they usually envision a massive body of boulders, gravel, sand, and dirt crashing down a hillside and destroying everything in its path. Rightly so, for that type of "mass wasting," as geologists call it, often occurs on landscapes dominated by steep slopes or frequent seismic activity. Several such landslides have been inventoried in Illinois and have caused hundreds of thousands of dollars in property damage. In the relatively young, low-relief, glacially sculpted landscape common to most of Illinois, however, more subtle mechanisms of mass wasting can be just as threatening and costly to engineers, community planners, and landowners as their more extreme but less common counterparts.

Nearly 60% of the landslides inventoried thus far in Illinois have been classified as "slumps" (Killey and others 1985). A slump is a mass of rock or earth that moves down along one or more underground surfaces of slippage within the mass or between the mass and the body of rock or earth beneath it. Slump-type landslides may be recognized by one or more of the following characteristics:

- a sharp cliff (also called a "scarp") several inches to several feet high that results from the initial downward movement
- one or more additional scarp faces resulting from successive slump movement
- poor drainage (ponding or development of marshy areas) due to disturbance of normal drainage patterns
- dead trees (due to root damage or excess moisture) and tilted trees, fence posts, and utility poles (Killey and others 1985).

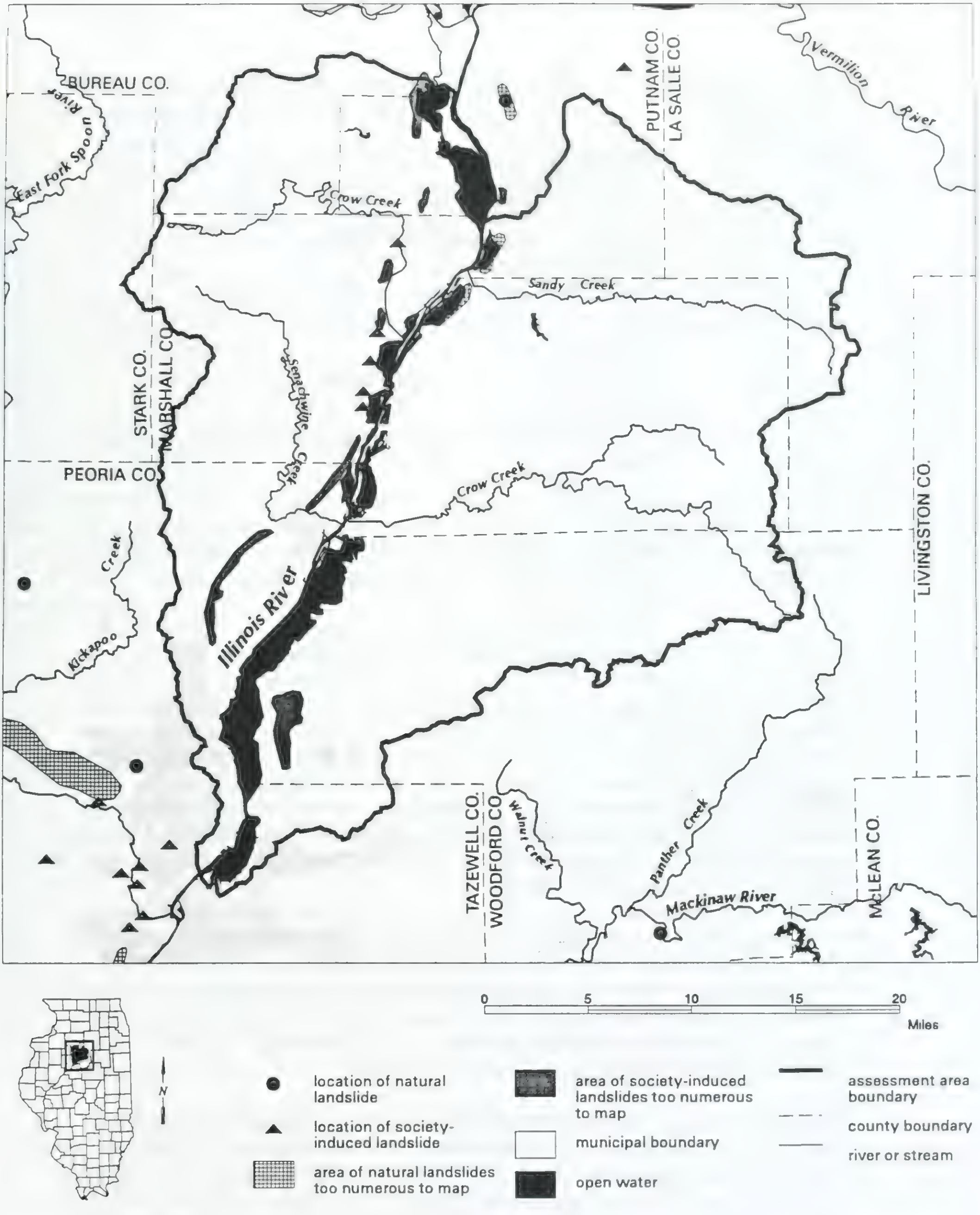

Figure 22. Landslide Inventory for the Illinois River Bluffs Assessment Area (Killey and others 1985)

Table 5. Landslide Inventory for the Illinois River Bluffs Assessment Area

County and Map No.	*Location*	*Cause*	*Type /Geologic Materials*
Marshall - 1	Illinois Rt. 29, 0.7 miles south of Sparland	Society-Induced	unclassified/NA
Marshall - 2	Illinois Rt. 29, 2.4 miles north of Sparland	Society-Induced	unclassified/NA
Marshall - 3	Along Crow Creek, northwest of Henry	Society-Induced	earth slump/NA
Marshall - 4	Illinois Rt. 29, 1.6 miles north of Sparland	Society-Induced	unclassified/NA
Marshall - 5	Illinois Rt. 29, south of Sparland	Society-Induced	rockslide/till and shale
Marshall - 6	Illinois Rt. 26, along Illinois River, east slope	Society-Induced	earthslump/loess
Putnam - 4	Illinois Rt. 26, along Illinois River, east slope	Society-Induced	earthslump/loess

Although data on landslides in the Illinois River Bluffs Assessment Area is limited, certain trends in landslide occurrence become apparent. As shown in Figure 22 and Table 5, all the reported landslides occur near the Illinois River or Crow Creek, and nearly all the landslides (save the Marshall - 3 landslide) occur adjacent to state highways. The basic information about the geology of the assessment area presented in this report can help us understand these patterns of occurrence.

Stream bank erosion, and the landslides that accompany it, is a natural and continual process; the path a stream travels is constantly changing to acquiesce to its environment. Abrupt changes in a stream's environment, such as bridge or road construction, will result in equally abrupt or forceful changes in the stream's path or erosive nature. The slumps occurring adjacent to state highways are undoubtedly the result of construction, and hence are categorized as society-induced.

The Marshall - 6 and Putnam - 4 landslides occurred within loess deposits on the east slope of the Illinois River. As explained above in the Soil Erosion and Sedimentation and Glacial and Surficial Geology sections, due to the prevailing westerly winds that picked up the finer sediments from the floodplains of the Illinois River, loess deposits are thickest on the east slopes of rivers; this fine loess is easily erodible by wind and water.

Thus, the potential for naturally occurring stream erosion, sometimes in the form of landslides, is high for the east slopes of the Illinois River.

Landslides in this area are also discussed in *Landslides near Peoria* (Ekblaw 1931). Additional information on landslides in Illinois is contained in *Landslide Inventory of Illinois* (Killey and others 1985), produced by the Illinois State Geological Survey in cooperation with the United States Geological Survey. This publication contains historical photos of landslides that have occurred in Illinois and provides essential information on landslide classification, factors contributing to landslide potential, and what can be done to stabilize landslides. It can be purchased from the Illinois State Geological Survey at (217) 333-ISGS.

Coal Mine Subsidence and Acid Drainage

The coal industry has long been an important component of the Illinois economy. Currently, coal generates approximately 40% of the electricity in the state. The Illinois coal mining industry directly and indirectly employs about 41,000 people (Bauer and others 1995). Despite its obvious economic contributions, coal production can also threaten many natural resources.

Mine subsidence (the sinking of land surface over mined-out areas) can damage structures and affect farmland productivity. Unreclaimed mine wastes can pollute air and water resources. Achieving a balance between the advantages and disadvantages of coal production can be aided when citizens are knowledgeable about past and present coal mining methods, and how these methods affect natural resources.

As shown in Figure 23, only a small part of the assessment area, concentrated at or near the towns of Toluca, Wenona, and Sparland, has been mined. No active mining of coal resources occurs today.

Piles of mining waste, commonly called "gob piles," can contribute to groundwater contamination. Composed mostly of shale (clay-rich rock) and poorer quality coal, the waste commonly contains sulfur-rich minerals, particularly pyrite and marcasite. These minerals react with rainfall and air to produce sulfuric acid; eventually, the sulfuric acid may drain or percolate into surface water and groundwater resources. The resulting increase in the acidity of the surface water can affect aquatic life and weaken concrete structures such as bridge piers, retainer walls, utility pipes, and well casings (Nuhfer and others 1993).

It is important to distinguish between "pre-law" and "post-law" mining activities and to describe the responsibilities that federal and state laws have placed on Illinois coal mining. All the environmental hazards described above result from pre-law mining activities and would not occur from any current or future mining activity.

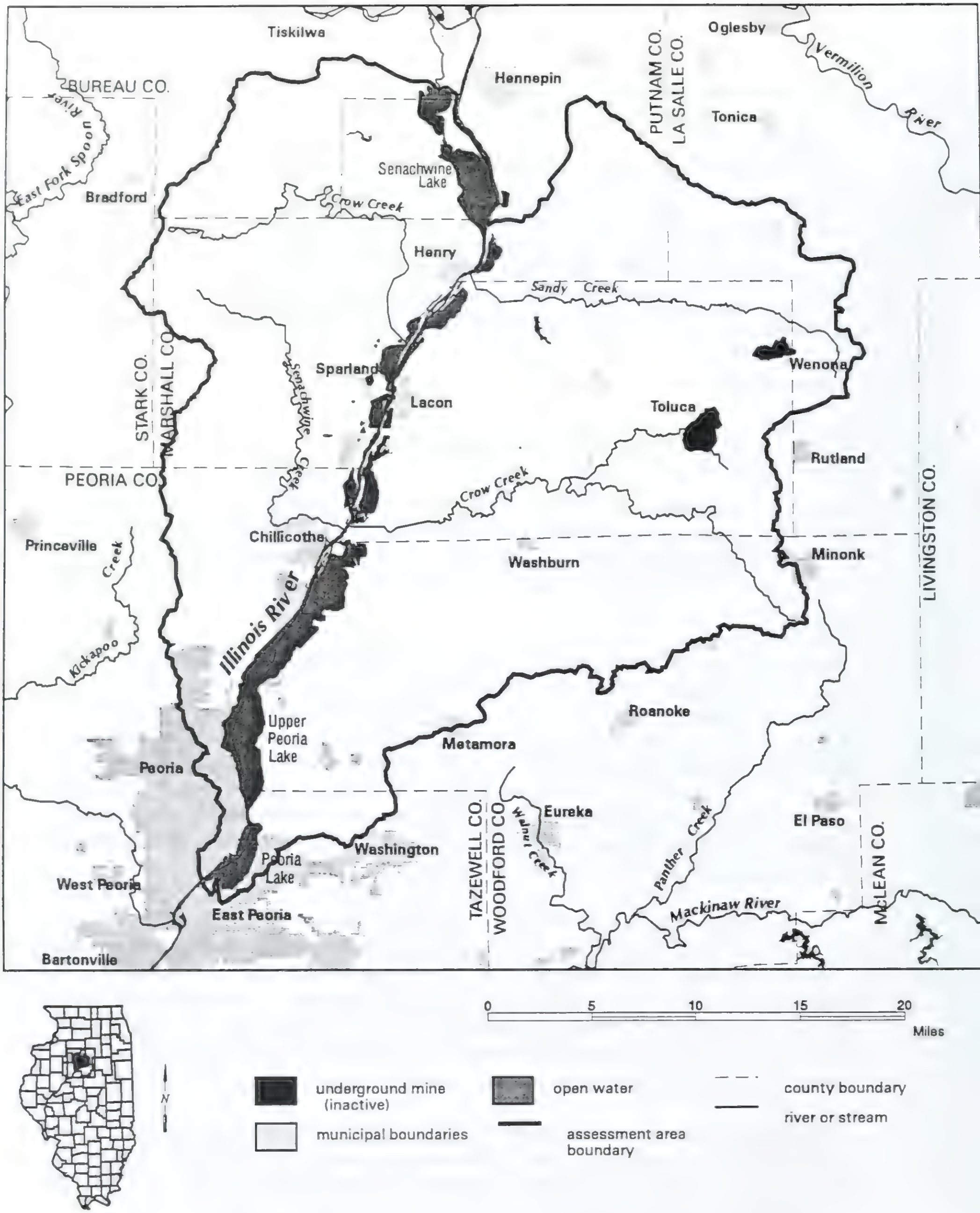

Figure 23. Coal Mines in the Illinois River Bluffs Assessment Area

Since the late 1970s, Illinois has had one of the nation's strictest and best enforced programs for regulating mining. To obtain a mining permit, companies must file a detailed report on the proposed mine area. The report must demonstrate that the mining activity will have no environmental impact outside the mine area and that after mining the land can and will be reclaimed to a condition equal to or better than before mining. To support their reclamation plans, companies must post with the state a bond for an amount deemed sufficient to reclaim the land. As the land is reclaimed, the bond is returned. If the company fails to reclaim the land properly, the bond is forfeited, and the state uses the money to do the reclamation work. Most companies find it cheaper to do the reclamation work properly themselves than to forfeit the bond.

Mines must report annually to the state on their mining and reclamation activities, and state inspectors regularly visit the mines to ensure that all activities are in compliance with the permit issued by the state. Underground mines are not allowed to subside the ground surface unless they have permission from the land owners. Even then, they may not subside the surface unless they demonstrate that all damage can and will be repaired and that the land will be returned to equal or better condition. Companies are also liable for any future damage from subsidence even after an area is no longer actively mined.

The Lands Unsuitable for Mining Program includes procedures allowing residents to petition that certain areas (such as special natural or historical sites) be declared "unsuitable for mining." The law also requires companies to contribute to a fund for cleaning up abandoned mine sites that are environmental or safety hazards. The fund will also cover future problems on abandoned mine properties.

Two essential publications for land-use planners and homeowners who want to learn more about coal mine subsidence are *Planned Coal Mine Subsidence in Illinois—A Public Information Booklet* and *Mine Subsidence in Illinois: Facts for Homeowners*. These booklets contain information on coal-mine reserves in Illinois, coal-mining methods, the history of subsidence in Illinois, what to do if subsidence occurs, and sources for additional information. Contact the Illinois State Geological Survey at (217) 333-4747 to request these publications.

References

Bauer, R.A., B.A. Trent, and P.B. DuMontelle, 1993. Mine Subsidence in Illinois: Facts for Homeowners. Illinois State Geological Survey, Environmental Geology 144, 16 p.

Bauer, R.A., B.A. Trent, B.B. Mehnert, and D.J. Van Roosendaal, 1995, Planned Coal Mine Subsidence in Illinois—A Public Information Booklet: Illinois State Geological Survey, 32 p.

Berg, C.R., and J.P Kempton, 1988, Stack-unit Mapping of Geologic Materials in Illinois to a Depth of 15 Meters: Illinois State Geological Survey Circular 542, 23 p.

Cobb, R.P., H.A.Wehrmann, and R.C. Berg, 1995, Guidance Document for Groundwater Protection Needs Assessments: Illinois Environmental Protection Agency, Report No. IEPA/PWS/95-01, 96 p.

Ekblaw, G., 1931, Landslides near Peoria: Illinois State Academy of Science, v. 24, p. 350–353.

Herzog, B.L., S.D. Wilson, D.R. Larson, E.C. Smith, T.H. Larson, and M.L. Greenslate, 1995, Hydrogeology and Groundwater Availability in Southwest McLean and Southwest Tazewell Counties, Part 1—Aquifer Characterization: Illinois State Geological Survey and Illinois State Water Survey Cooperative Groundwater Report 17, 70 p.

Keefer, D.A., 1995, Potential for Agricultural Chemical Contamination of Aquifers in Illinois, 1995 Revision: Illinois State Geological Survey Environmental Geology 148, 18 p.

Killey, M.M., J.K. Hines, and P.B. DuMontelle, 1985, Landslide Inventory of Illinois: Illinois State Geological Survey Circular 534, 27 p.

Nuhfer, E.B., R.J. Proctor, and P.H. Moser, 1993, Citizens' Guide to Geologic Hazards: American Institute of Professional Geologists, Arvada, CO, 134 p.

Risatti, J.B., and E. Mehnert, 1995, Transport and fate of agrichemicals in an alluvial aquifer during normal and flood conditions—A status report, *in* Research on Agricultural Chemistry in Illinois Groundwater—Status and Future Directions V: Illinois Groundwater Consortium Fifth Annual Conference Proceedings March 29–30, 1996, Makanda, Illinois, p. 29–38.

Schock, S.C., E. Mehnert, M.E. Caughey, G.B. Dreher, W.S. Dey, S. Wilson, C. Ray, S.-F.J. Chou, J. Valkenburg, J.M. Gosar, J.R. Karny, M.L. Barnhardt, W.F. Black, M.R. Brown, and V.J. Garcia, 1992, Pilot Study—Agricultural Chemicals in Rural, Pivate Wells in Illinois: Illinois State Geological Survey and Illinois State Water Survey Cooperative Groundwater Report 14, 80 p.

Appendix A: Overview of Databases

Illinois Wetlands Inventory

This digital database contains the location and classification of wetland and deepwater habitats in Illinois. Following U.S. Fish and Wildlife Service definitions, the Illinois Natural History Survey (INHS) compiled the information from interpretations of 1:58,000-scale high-altitude photographs taken between 1980 and 1987. Identifiable wetlands and deepwater habitats were represented by points, lines, and polygons on 1:24,000-scale U.S. Geological Survey (USGS) 7.5- minute quadrangle maps. These data were digitized and compiled into the Illinois Wetlands Inventory. Because no wetland or deep-water habitats smaller than 0.01 acres were included, many farmed wetlands are not in the database. This database is appropriate for analysis on a local and regional scale; due to the dynamics of wetland systems, however, boundaries and classifications may change over time. For detailed explanation of wetland classification in Illinois, see Wetland Resources of Illinois: An Analysis and Atlas (Suloway and Hubbell 1994).

Quaternary Deposits of Illinois

Originally automated in 1984, this database is the digital representation of the 1:500,000-scale map *Quaternary Deposits in Illinois* (Lineback 1979). Because these data, modified by Hansel and Johnson (1996), represent a generalization of the glacial sediments that lie at or near the land surface, this database is most appropriate for use at a regional scale. For further information about surficial deposits in Illinois, see *Wedron and Mason Groups: Lithostratigraphic Reclassification of the Wisconsin Episode, Lake Michigan Lobe Area* (Hansel and Johnson 1996).

Thickness of Loess in Illinois

This database contains 5-foot-interval contour lines indicating loess thickness on uneroded upland areas in Illinois. These data were originally automated in 1986 from the 1:500,000-scale map in *Glacial Drift in Illinois—Thickness and Character* (Piskin and Bergstrom 1975, plate 1). This database is most appropriate for use at a regional scale.

Thickness of Surficial Deposits

This database contains polygons delineating glacial and stream materials throughout the state, with thicknesses ranging from less than 25 feet to greater than 500 feet. The data were originally automated in 1986 from the 1:500,000-scale map in *Glacial Drift in Illinois—Thickness and Character* (Piskin and Bergstrom 1975, plate 1). This database is most appropriate for use at a regional scale.

Noncoal Mineral Industry Database

Compiled by the ISGS from Illinois Office of Mines and Minerals permit data and information from the ISGS Directory of Illinois Mineral Producers, this database contains the locations of mineral extraction operations (other than coal, oil, and gas producers) in

Illinois. The database contains both active and inactive sites and is updated every year. The 1996 data include 7 active underground mines and 449 active surface pits and quarries. This is a point database and is appropriate for analysis on a local to regional scale. For more information on the current locations of noncoal mineral extraction sites or on the location of potential noncoal mineral resources, contact the Industrial Minerals Section of the Illinois State Geological Survey.

1:100,000-Scale Topography of Illinois

Depicting the general configuration and relief of the land surface in Illinois, this database was compiled by the ISGS from 1:100,000-scale digital line graph (DLG) format data files, originally automated by the USGS from USGS 1:100,000-scale 30- by 60-minute quadrangle maps. The USGS collected the land surface relief data for Illinois from stable-base manuscripts, photographic reductions, and stable-base composites of the original 1:100,000 map separates using manual, semiautomatic, and automatic digitizing systems. The contour interval of this topographic data is 5.0 meters (16.4 feet). These digital data are useful for the production of intermediate- to regional-scale base maps and for a variety of spatial analyses, such as determining the slope of a geographic area. DLG format topographic data are available from the USGS and can be down loaded on the Internet from

http://edcwww.cr.usgs.gov/glis/hyper/guide/100kdlgfig/states/Il.html

A full description of the DLG format can be found in the *Digital Line Graphs from 1:100,000-Scale Maps—Data Users Guide 2* produced by the USGS. These data are also available from the ISGS in ARC format.

State Soil Geographic (STATSGO) Data Base for Illinois

The Illinois STATSGO was compiled by the USDA Natural Resources Conservation Service (NRCS). The database is the result of generalizing available county-level soil surveys into a general soil association map. If no county survey was available, data on geology, topography, vegetation, and climate were assembled along with Land Remote Sensing Satellite (LANDSAT) images. Soils of like areas were studied, and the probable classification and extent of the soils were determined. The data were compiled at 1:250,000-scale using USGS 1- by 2- degree quadrangle maps. This database was designed to be used primarily for regional, multistate, state, and river basin resource planning, management, and monitoring. It is not intended to be used at the county level. Illinois STATSGO data are available in DLG, ASCII, or ARC format and can be downloaded on the Internet from

http://www.gis.uiuc.edu/nrcs/soil.html

The data are also available from the ISGS in ARC format. For more information visit the USDA web site or contact the Natural Resources Conservation Service, 1902 Fox Drive, Champaign, IL 61820.

Land Cover Database of Illinois

Compiled for the IDNR Critical Trends Assessment Project by the INHS, the land cover database is intended as a base line for assessment and management of biologic natural resources in Illinois. Twenty-three major land cover classes were defined using Thematic Mapper (TM) Satellite data. Dates of the imagery range from April 1991 to May 1995. Ancillary data used to interpret the TM imagery include the 1992 Topologically Integrated Geographic Encoding and Referencing System (TIGER) line files, the Illinois Wetlands Inventory, NRCS county crop compliance data, 1988 National Aerial Photography Program (NAPP) photography, and USGS transportation and hydrography data. This database is most appropriate for use at medium and regional scales. For more information on land cover in Illinois see *Illinois Land Cover—An Atlas* (Illinois Department of Natural Resources 1996).

References

Hansel, A.K., and W.H. Johnson, 1996, Wedron and Mason Groups—Lithostratigraphic Reclassification of Deposits of the Wisconsin Episode, Lake Michigan Lobe Area: Illinois State Geological Survey Bulletin 104, 116 p.; plate 1, Quaternary Deposits of Illinois. Revised map.

Illinois Land Cover—An Atlas, 1996: Illinois Department of Natural Resources, Springfield, Illinois, IDNR/EEA-96/05, 157 p.

Lineback, J.A., compiler, 1979, Quaternary Deposits of Illinois: Illinois State Geological Survey 1:500,000 scale map.

Piskin, K., and R.E. Bergstrom, 1975, Glacial Drift in Illinois—Thickness and Character: Illinois State Geological Survey Circular 490, 35 p.

Suloway, L., and M. Hubble, 1994, Wetland Resources of Illinois—An Analysis and Atlas: Illinois Natural History Special Publication 15, 88 p.

Appendix B: Land Cover by Subbasin

Illinois River (upper)				
Land Cover Category	*Sq. Mi.*	*Acres*	*%Subbasin*	*%Area*
Agricultural Land	**78.9**	**50,517**	**70.6**	**9.0**
Cropland	61.8	39,576	55.3	7.1
Rural Grassland	17.1	10,941	15.3	2.0
Forest & Woodland	**14.4**	**9,215**	**12.9**	**1.6**
Urban & Built-Up Land	**1.8**	**1,136**	**1.6**	**0.2**
Urban/Built-Up	0.9	555	0.8	0.1
Urban Grassland	0.9	582	0.8	0.1
Wetland	**5.3**	**3,368**	**4.7**	**0.6**
Forested	4.1	2,634	3.7	0.5
Nonforested	1.1	734	1.0	0.1
Other Land	**11.4**	**7,278**	**10.2**	**1.3**
Lakes & Streams	11.3	7,251	10.1	1.3
Barren & Exposed	0.0	26	0.0	0.0
Totals	**111.7**	**71,514**	**100.0**	**12.7**

Crow Creek West				
Land Cover Category	*Sq. Mi.*	*Acres*	*%Subbasin*	*%Area*
Agricultural Land	**71.6**	**45,795**	**89.6**	**8.2**
Cropland	57.4	36,713	71.8	6.6
Rural Grassland	14.2	9,082	17.8	1.6
Forest & Woodland	**6.8**	**4,345**	**8.5**	**0.8**
Urban & Built-Up Land	**0.2**	**117**	**0.2**	**0.0**
Urban/Built-Up	0.1	70	0.1	0.0
Urban Grassland	0.1	47	0.1	0.0
Wetland	**0.7**	**427**	**0.8**	**0.1**
Forested	0.5	315	0.6	0.1
Nonforested	0.2	112	0.2	0.0
Other Land	**0.7**	**442**	**0.9**	**0.1**
Lakes & Streams	0.7	421	0.8	0.1
Barren & Exposed	0.0	21	0.0	0.0
Totals	**79.9**	**51,127**	**100.0**	**9.1**

Sandy Creek

Land Cover Category	*Sq. Mi.*	*Acres*	*% Subbasin*	*% Area*
Agricultural Land	**126.0**	**80,644**	**88.5**	**14.4**
Cropland	108.4	69,358	76.1	12.4
Rural Grassland	17.6	11,286	12.4	2.0
Forest & Woodland	**10.2**	**6,526**	**7.2**	**1.2**
Urban & Built-Up Land	**3.9**	**2,478**	**2.7**	**0.4**
Urban/Built-Up	2.2	1,396	1.5	0.3
Urban Grassland	1.7	1,082	1.2	0.2
Wetland	**0.6**	**387**	**0.4**	**0.1**
Forested	0.4	236	0.3	0.0
Nonforested	0.2	150	0.2	0.0
Other Land	**1.6**	**1,054**	**1.2**	**0.2**
Lakes & Streams	1.6	1,042	1.1	0.2
Barren & Exposed	0.0	11	0.0	0.0
Totals	**142.3**	**91,088**	**100.0**	**16.2**

Illinois River (lower)

Land Cover Category	*Sq. Mi.*	*Acres*	*%Subbasin*	*%Area*
Agricultural Land	**182.7**	**116,950**	**56.3**	**20.9**
Cropland	135.8	86,932	41.8	15.5
Rural Grassland	46.9	30,018	14.4	5.4
Forest & Woodland	**68.4**	**43,803**	**21.1**	**7.8**
Urban & Built-Up Land	**18.9**	**12,066**	**5.8**	**2.2**
Urban/Built-Up	13.2	8,455	4.1	1.5
Urban Grassland	5.6	3,611	1.7	0.6
Wetland	**40.7**	**26,077**	**12.5**	**4.7**
Forested	13.3	8,488	4.1	1.5
Nonforested	27.5	17,589	8.5	3.1
Other Land	**14.0**	**8,954**	**4.3**	**1.6**
Lakes & Streams	13.8	8,817	4.2	1.6
Barren & Exposed	0.2	137	0.1	0.0
Totals	**324.8**	**207,849**	**100.0**	**37.1**

Senachwine Creek Subbasin

Land Cover Category	*Sq. Mi.*	*Acres*	*%Subbasin*	*%Area*
Agricultural Land	**72.7**	**46,510**	**80.8**	**8.3**
Cropland	57.2	36,605	63.6	6.5
Rural Grassland	15.5	9,904	17.2	1.8
Forest & Woodland	**12.8**	**8,182**	**14.2**	**1.5**
Urban & Built-Up Land	**1.4**	**881**	**1.5**	**0.2**
Urban/Built-Up	1.1	726	1.3	0.1
Urban Grassland	0.2	154	0.3	0.0
Wetland	**1.7**	**1,117**	**1.9**	**0.2**
Forested	1.3	860	1.5	0.2
Nonforested	0.4	257	0.5	0.1
Other Land	**1.4**	**896**	**1.6**	**0.2**
Lakes & Streams	1.4	886	1.5	0.2
Barren & Exposed	0.0	10	0.0	0.0
Totals	**90.0**	**57,585**	**100.0**	**10.3**

North Branch Crow Creek East

Land Cover Category	*Sq. Mi.*	*Acres*	*%Subbasin*	*%Area*
Agricultural Land	**28.8**	**18,403**	**94.5**	**3.3**
Cropland	25.9	16,550	85.0	3.0
Rural Grassland	2.9	1,853	9.5	0.3
Forest & Woodland	**0.4**	**238**	**1.2**	**0.0**
Urban & Built-Up Land	**1.0**	**617**	**3.2**	**0.1**
Urban/Built-Up	0.7	437	2.2	0.1
Urban Grassland	0.3	180	0.9	0.0
Wetland	**0.1**	**42**	**0.2**	**0.0**
Forested	0.0	31	0.2	0.0
Nonforested	0.0	11	0.1	0.0
Other Land	**0.3**	**180**	**0.9**	**0.0**
Lakes & Streams	0.3	180	0.9	0.0
Totals	**30.4**	**19,480**	**100.0**	**3.4**

Crow Creek East

Land Cover Category	*Sq. Mi.*	*Acres*	*%Subbasin*	*%Area*
Agricultural Land	**23.8**	**15,244**	**76.8**	**2.7**
Cropland	15.9	10,182	51.3	1.8
Rural Grassland	7.9	5,061	25.5	0.9
Forest & Woodland	**5.2**	**3,317**	**16.7**	**0.6**
Urban & Built-Up Land	**0.3**	**190**	**1.0**	**0.0**
Urban/Built-Up	0.3	190	1.0	0.0
Wetland	**1.3**	**802**	**4.0**	**0.1**
Forested	0.8	510	2.6	0.1
Nonforested	0.5	292	1.5	0.1
Other Land	**0.5**	**296**	**1.5**	**0.1**
Lakes & Streams	0.4	268	1.4	0.1
Barren & Exposed	0.0	29	0.1	0.0
Totals	**31.0**	**19,849**	**100.0**	**3.5**

South Branch Crow Creek East

Land Cover Category	*Sq. Mi.*	*Acres*	*%Subbasin*	*%Area*
Agricultural Land	**64.1**	**41,000**	**96.7**	**7.3**
Cropland	58.3	37,293	88.0	6.7
Rural Grassland	5.8	3,708	8.8	0.7
Forest & Woodland	**0.7**	**440**	**1.0**	**0.1**
Urban & Built-Up Land	**0.6**	**360**	**0.9**	**0.1**
Urban/Built-Up	0.3	192	0.5	0.0
Urban Grassland	0.3	168	0.4	0.0
Wetland	**0.3**	**212**	**0.5**	**0.0**
Forested	0.2	138	0.3	0.0
Nonforested	0.1	75	0.2	0.0
Other Land	**0.6**	**372**	**0.9**	**0.1**
Lakes & Streams	0.6	372	0.9	0.1
Totals	**66.2**	**42,385**	**100.0**	**7.6**